Crop Production Techniques of Horticultural Crops

1999

Department of Horticulture and Plantation Crops
Chepauk, Chennai 600 005.

Tamil Nadu Agricultural University
Coimbatore 641 003.

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OF
HORTICULTURAL CROPS – 1999

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Department of Horticulture and Plantation Crops
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March, 1999

FOREWORD

Horticultural crops play an important role in the national economy and the health of the people. The importance of fruits and vegetables is currently well recognised for their role in providing a balanced food. The impact of enhanced investment in horticulture has been highly encouraging in terms of greatly increased production. The production of horticultural produces in India has increased from 96.11 million tonnes in 1991-92 to 141.06 million tonnes in 1996-97. In the 9th five-year plan the production target of 183.90 million tonnes of horticultural crops for the country is being aimed.

In Tamil Nadu, horticultural crops occupy 8.0% of the gross cropped area, viz., about 6.88 lakhs ha, which accounts for a production of 10.14 million tonnes. Population growth and urbanization are creating increased demand for food. Fast urbanization may not offer scope for expansion of area. Production has to be achieved through vertical expansion through increased productivity of individual crops. Thanks to the researchers and extension workers who have already achieved increased productivity in fruits from 17.43 to 24.50 t/ha and in vegetables from 18.02 to 28.11 t/ha during the years 1980 to 1996.

Horticulture scenario is now based on technology based production system. Introduction of high yielding varieties and adoption of improved production technologies will help to increase the productivity. The recent trends of high economic returns with better cultural practices to conserve the environmental ecosystems have been given importance by the horticultural scientists and horticultural extension workers. Tamil Nadu Agricultural University has a mandate to strive for the productivity and ecofriendly cultivation of crops through research projects. A holistic approach is made in providing improved crop production technologies.

I am happy that the revised *Manual on Crop Production Techniques of Horticultural Crops* is being brought out. It has been updated with the latest research findings and revised suitably to the present-day needs.

I convey my sincere appreciation to the Horticultural research workers of the Tamil Nadu Agricultural University and the Horticultural extension workers of the Department of Horticulture and Plantation Crops for bringing out this revised document. I am confident that this manual will greatly help to increase the productivity and quality of the horticultural crops.

A. ABDUL KAREEM
Vice-chancellor

N. ATHIMOOLAM, I.A.S.,
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FOREWORD

I am happy to learn that a Manual on Crop Production Techniques for Horticultural Crops is being brought out now. It is quite necessary that updating of this important technical manual is done regularly incorporating the latest technologies. Since technological developments are taking place at a faster pace, the extension staff should have access to such new changes in the filed of Horticulture. I am sure that the new manual would meet the requirements of the staff of the Department as well the growers of horticultural crops.

I convey my appreciation to all those who are involved in this task both in the Department of Horticulture and in the Tamil Nadu Agricultural University.

(N. ATHIMOOLAM)
SECRETARY TO GOVERNMENT.

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MARCH 1999

FOREWORD

Tamil nadu has great potential for the cultivation of horticultural crops on account of its varied agro-climatic conditions. Horticultural Crops are cultivated in 7.5 lakh Ha. in our State. There has been a steady increase in area of horticultural crops in the recent past since cultivation of horticultural crops is becoming more lucrative than other crops.

Successful cultivation of crops is based on sound technologies, which leads to increased productivity. It is very essential to disseminate the recent technologies to the growers in an effective way for which the extension staffs are to be equipped with all the latest technologies including Hi-tech areas. Against this background, a manual on Crop Production Techniques of Horticultural Crops – 1999 has been prepared jointly by the Department of Horticulture and Tamil Nadu Agricultural University. I strongly believe that this manual will cater to the needs of planners, extension workers, growers and others concerned for promotion of horticulture development on a sound basis.

(VIKRAM KAPUR)

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Chapter A

Tropical and Sub Tropical Fruits

Mango

***Mangifera indica* L.**

Anacardiaceae

Varieties

Neelum, Bangalora, Alphonso, Rumani, Banganapalli, Kalepad, Peter, PKM 1, PKM 2, Sendura, Jahangir, Mulgoa, Himayuddin, Paiyur 1, Mallika, Amrapali and Salem Bangalora.

Soil and climate

Red loamy soil with good drainage is preferable. pH range 6.5 to 8.

Season of planting

July to December.

Planting material

Grafts.

Field preparation

Dig pits of 1 m x 1 m x 1 m. Fill in with topsoil mixed with 10 kg of FYM and 100 g Lindane 1.3% dust per pit.

Planting

Plant grafts in the centre of pit with ball of earth intact, water and stake. The graft union must be 15 cm above the ground level.

Spacing

Spacing 7 to 10 m either way.

Irrigation

Regular watering till establishment.

Intercropping

Short duration crops like legumes, vegetables, groundnut etc. can be raised during pre-bearing age.

Manures and fertilizers (Kg per tree)

Manures and Fertilizers	1 Year old	Annual increase	6th year onwards
FYM	10.00	10.00	50
N	0.20	0.20	1.0
P	0.20	0.20	1.0
K	0.30	0.30	1.5

Manures and fertilizers may be applied in September – October, 45 – 90 cm away from the trunk upto the peripheral leaf drip and incorporated.

Training and pruning

Rootstock sprouts and low lying branches have to be removed. Remove overlapping, intercrossing, diseased, dried and weak branches in old trees to get good sunlight and aeration. For the internal branches, pruning may be done during August – September, once in three years. Flowering should not be allowed upto three years. Among crowded terminal shoots, weak shoots are thinned to retain two healthy shoots during August-September annually.

Growth regulators

Spray NAA @ 20 ppm at flowering to increase the fruit retention. During February 0.5% Urea (5 g/lit.) or 1% Potassium Nitrate (10g/lit.) may be sprayed to induce flowering, if trees do not flower by that time.

Plant protection

Pests

Hopper

Spray two rounds of Acephate 75 SP@ 1g/lit. or Phosalone 35 EC@ 1.5 ml/lit or Carbaryl 50 WP 2 g/lit. or Phosphamidon 85 WSC 1 ml/lit of water. First at the time of panicle emergence and the second two weeks after first spray. Wettable Sulphur @ 2 g/lit. may be sprayed after spraying Carbaryl to avoid mite resurgence. Phosphamidon + Neem oil 5 ml/lit of water can be mixed with any insecticides for the control of hopper and shoot webber.

Leaf galls and aphids

Dimethoate or Methyl demeton 2 ml/lit.

Flower webber

Phosalone 35 EC 2 ml/lit

Nut weevil

Fenthion 100 EC 1ml/lit spray during marble stage and second spray 15 days after the first spray.

Mealy bug

Chlorpyriphos 20 EC 2.5ml/lit. or Monocrotophos 36 WSC 1.5ml/lit.

Release of Australian lady bird beetle, *Cryptolaemus montrouzieri* @ 10/tree.

Stem borer

i) Padding with Monocrotophos 36 WSC 10 ml per tree soaked in absorbent cotton when the trees are not in bearing stage.

ii) Application of Carbofuran 3G 5g per bore hole and plugging with mud after mechanically removing or killing the grub by introducing a needle or wire.

Fruit fly

Fenthion 2 ml/lit or Malathion 2 ml/lit. Plough the inter spaces to expose pupae. Prepare Methyl Eugenol 1 ml in 1 litre of water + 1 ml of Malathion solution. Take 10 ml of this mixture per trap and keep them in 25 different places in one hectare between 6 a.m. and 8 a.m. Collect and destroy the adult flies. Collect and destroy the affected fallen fruits.

Safe waiting period

Dimethoate, Methyl Demeton and Fenthion – 14 days.

Diseases

Powdery mildew

Apply Sulphur dust (350 mesh) in the early morning to protect new flush or spray Wettable sulphur 0.2% or Tridemorph 0.05%.

Anthracnose and stalk end-rot

Spray Mancozeb 2g/lit or Carbendazim 1g/lit or Thiophanate methyl 1g/lit or Chlorothalonil 2 g/lit as pre-harvest spray, 3 times at 15 days interval.

Sooty mould

Spray Phosphamidon 85 WSC 2ml/lit + Maida 5% (1 kg Maida or starch boiled with 1 lit of water and diluted to 20 litres). Avoid spraying during cloudy weather.

Nematodes in potting mixture for fruit crops

For one m^3 of heaped potting mixture apply 130 litres of 0.5% formaldehyde (1.6 lit of

commercial formaldehyde 40% in 130 litres of water). The heap is allowed to stand undisturbed for one week atleast and then disturbed and aerated to eliminate the residual fumigant in soil. The fumigated soil can be used in polybags for raising seedlings or rooted cuttings. Besides nematodes. soil borne fungi and bacteria are also killed.

Harvest season

March to June.

Harvest

Yield varies with varieties and spacing adopted.

8 – 10 t/ha upto 15 years.

15 – 20 t/ha from 15 – 20 years.

Post harvest treatment

Dip the fruits in 52 ± 1°C hot water immediately after harvest for 5 minutes followed by 8% plant wax (Fruitox or Waxol) to reduce anthracnose disease in mango during storage. Two pre-harvest sprays of 0.20% Mancozeb (2.0 g/lit) will also reduce the incidence.

Waiting Period

Methyl demeton 0.05%	14 days
Fenthion 0.05%	14 days
Quinalphos 0.05%	12 days
Lindane 300 g a.i./ha	2 days

Banana

Musa sp

Musaceae

Varieties

Dessert

Robusta, Dwarf Cavendish, Rasthali, Vayal Vazhai, Poovan, Nendran, Red Banana. Karpooravalli, Co.1, Matti, Sannachenkadali and Neypoovan.

Culinary

Monthan, Nendran, Vayal Vazhai, Ash Monthan and Chakkia.

Hill varieties

Virupakshi, Sirumalai, Namarai, Red Banana, Manoranjitham (Santhana Vazhai) and Ladan.

Soil and Climate

Well drained loamy soils are suitable. Alkaline and saline soils should be avoided.

Season of planting

Wet lands

Feb – April : Poovan, Rasthali, Monthan, Karpooravalli and Neypoovan.

April – May : Nendran and Robusta

Garden lands

January – February and November – December.

Padugai lands

January – February and August – September.

Hill Banana

April – May (lower Palani hills), June – August (Sirumalai)

Selection and pre-treatment of suckers

Select sword suckers of 1.5 to 2.0 kg weight, free from diseases and nematodes. Trim the roots and decayed portion of the corm, cut the pseudostem leaving 20 cm from the corm and grade the suckers to size. To avoid wilt disease, infected portions of the corm may be pared, dipped for 5 minutes in 0.1% Emisan solution (1 g in 1 lit of water) in Rasthali, Monthan, Neyvannan, Virupakshi and other wilt susceptible varieties. Pralinage with 40 g of Carbofuran 3 G granules per sucker. (Dip the corm in slurry solution of 4 parts clay plus 5 parts water and sprinkle Carbofuran to control nematodes). Alternatively, dip the corm with 0.75% Monocrotophos, shade dry for atleast 24 hours and plant. Sow Sunhemp on 45th day; incorporate it after about a month. This operation reduces nematode build up.

Field preparation

Wet lands

No preparatory cultivation is necessary.

Garden land

2 – 4 ploughings.

Padugai

One deep mammutti digging.

Hill Banana

Remove scrub jungle and construct contour stone walls.

Digging pits

Wet lands

Place the suckers at ground level and earth up at different stages.

Garden land, padugai and Hill areas

Dig pits of 45 cm x 45 cm x 45 cm size. The pits are refilled with topsoil, mixed with 10 kg of FYM, 250 g of neem cake and 50 g of Lindane 1.3 % to each pit.

Spacing

	Variety	Spacing	No. of plants/ha
Garden land	Robusta, Nendran	1.8 x 1.8 m	3086
	Dwarf Cavendish	1.5 x 1.5 m	4444
Wetland	Poovan, Monthan Rasthali, Neyvannan, Neypoovan	2.1 x 2.1 m	2267
Hills	Virupakshi (Sirumalai), Namarai and Ladan	3.6 x 3.6 m	750 (When mixed with coffee)

Irrigation

Irrigate immediately after planting; give life irrigation after 4 days; subsequent irrigations are to be given once in a week for irrigated plantations of garden lands and once in 10 – 15 days for wetlands. Irrigate the fields copiously after every manuring.

Application of fertilizers

General recommendations for garden land, wetland and hill bananas

Details	N	P	K
	(g/plant/year)		
Garden land			
Varieties other than Nendran	110	35	330
Nendran	150	90	300
Wetland			
Nendran	210	35	450
Rasthali	210	50	390
Poovan, Robusta	160	50	390

Hill bananas
After forming semicircular basins on uphill side, apply 375 g of 40:30:40 NPK mixture, plus 130 g muriate of potash per clump per application during October, January and April. Apply *Azospirillum* and *Phosphobacterium* 20 gm each at planting and 5th month after planting preceding chemical fertilizer application.

Apply N as neem coated urea. Apply N and K in 3 splits on 3rd, 5th and 7th month. Phosphorous at 3rd month of planting. Apply 20 g each of *Azospirillum* and *Phosphobacteria* at planting and five months after planting. (This should be applied prior to chemical fertilizer application).

Aftercultivation

Garden land

Give mammutti digging at bi-monthly intervals and earth up. Prune the suckers at monthly intervals. The dry and diseased leaves are removed and burnt to control the spread of leaf spot diseases. Male flowers may be removed a week after opening of last hand. In Robusta banana to avoid 'fingertip disease' floral remnants may be removed a week after opening of the last hand. The plants at flowering may be propped. Cover the peduncle with flag leaf to prevent main stalk end rot. Cover the bunches with banana leaves to avoid sunscald.

Wetland

Form trenches in between alternate rows and cross trenches at every 5th row. The trenches are periodically deepened and the soil is spread over the bed. Surface diggings may be given at bi-monthly intervals and desuckering at monthly intervals. Remove the male flower a week after opening of last hand. Prop plants at or prior to flowering. Cover the peduncle with flag leaf and the bunch with leaves to avoid sunscald. For ratoon crops in respect of Poovan, Monthan and Rasthali allow the follower at flowering of the mother plant and remove the other suckers at harvest.

Perennial banana

Give surface digging with mammutti once in two months. Give one deep digging with mammutti during January – February. Other operations as in gardenland.

Hill banana

Give four forkings in January, April, July and October. Remove outer sheaths to keep the corm inside the soil and ward off borer. Maintain two bearing plants and two followers per clump along the contour.

Growth regulators

To improve the grade of bunches 2,4 – D at 25 ppm (25 mg/lit.) may be sprayed in Poovan and Co 1 banana after the last hand has opened. This will also help to remove seediness in Poovan variety.

Intercropping

Leguminous vegetables, beetroot, elephant foot yam and sunhemp. Avoid growing cucurbitaceous vegetables.

Plant protection

Pests

Corm weevil

Apply Lindane 1.3% 20 g/plant or Carbaryl 10 – 20 g/plant in the soil around the stem.

Stem weevil (*Odoiporus longicollis*)

Remove dried leaves periodically and keep the plantation clean. Prune the suckers every month. Spray Monocrotophos 36 WSC @ 1 ml/lit of water. Alternatively, dilute 50 ml of Monocrotophos 36 WSC with 350 ml of water and inject 4 ml (2 ml at 45 cm from the ground level another 2 ml 150 cm from the ground level) in the pseudostem at monthly intervals from 5th to 8th month. Do not dump infected materials into the manure pit. Infected trees should be uprooted, chopped into pieces and burnt.

Banana aphid

The pest is the vector for bunchy top virus disease. Spray any one of the following systemic insecticides to control it. Phosphamidon 1 ml/lit, Methyl demeton 2 ml/lit, Monocrotophos 1 ml/lit Dimethoale 30 EC 2 ml/lit. The spray may be directed towards crown and pseudostem base upto ground level at 21 days interval atleast thrice. Injection of Monocrotophos 36 WSC 1 ml/plant (1 ml diluted in 4 ml of water) at 45 days interval from the 3rd month till flowering is very effective. Use 'Banana injector' devised by the Tamil Nadu Agriculture University. Avoid injection of Monocrotophos after flowering.

Thrips and lace wing bugs

Spray Methyl demeton 20 EC 2 ml/lit or Monocrotophos 36 WSC 1 ml/lit or Phosphamidon 85 EC 1 ml/lit.

Nematode

Pre-treat the suckers with 40 g Carbofuran 3G. If pre-treatment is not done, apply 40 g of Carbofuran around each plant one month after planting (refer selection and pre-treatment for alternate technology) or pare and dip the corm 0.75% Monocrotophos solution shade dry and plant. Then grow sunhemp after 45th day and incorporate one month later.

Diseases

Sigatoka leaf spot

Remove affected leaves and burn. Spray any one of the following fungicides commencing from November at monthly intervals. Carbendazim 1 g/lit., Benomyl 1 g/lit., Mancozeb 2 g/lit., Copper oxychloride 2.5 g/lit., Ziram 2 ml/lit, Chlorothalonil 2 g/lit. Alternation of fungicides prevents fungicidal resistance. Always add 5 ml of wetting agent like Sandovit, Triton AE, Teepol etc. per 10 lit of spray fluid.

Bunchy top

The banana aphid *Pentalonia nigronervosa* is the vector of bunchy top virus disease. Spray any one of the following systemic insecticides to control it.

Phosphamidon 1 ml/lit or Methyl demeton 2 ml/lit or Monocrotophos 1 ml/lit.

The spray may be directed towards crown and pseudostem base upto ground level at 21 days interval atleast thrice. Injection of Monocrotophos 36 WSC 1 ml/plant (1 ml diluted in 4 ml of water) at 45 days interval from the 3rd month till flowering is very effective. Use 'Banana Injector' devised by the Tamil Nadu Agricultural University. Avoid injection of Monocrotophos after flowering.

To prevent the disease,

i) Use virus-free suckers

ii) Paring and pralinage

Pare the corm and sprinkle 40 g of Carbofuran 3 G over the corm (before sprinkling, corm should be dipped in mud slurry)

iii) Destroy virus affected plants.

Insert a gelatin capsule containing 200 mg Fernoxone (2,4 – D) into the corm 7 cm deep using capsule applicator or inject 5 ml Fernoxone solution (125 gm/lit of water) into the pseudostem by using the injection gun. The plant collapses and topples in 3 – 5 days.

Panama disease

Uproot and destroy severely affected plants. Apply lime at 1 – 2 kg in the pits after removal of the affected plants. In the field Panama wilt disease can be prevented by corm injection methods. A small portion of soil is removed to expose the upper portion of the corm. An oblique hole at 45° angle is made to a depth of 10 cm. Immediately, a gelatin capsule containing 60 mg of Carbendazim or 3 ml of 2% Carbendazim solution is injected into the hole with the help of 'corm injector' on 2nd, 4th and 6th month after planting. Application of press mud at 5kg per tree reduces the wilt incidence.

Kottaivazhai in Poovan

Spray 2,4 – D at the rate of 25 ppm within 20 days after opening of last hand (1 g/40 lit/ 200 bunches) or 1.2 g of Sodium salt of 2,4 – D dissolved in 40 lit. of water for 200 bunches.

Crop duration

The bunches will be ready for harvest after 12 to 15 months of planting.

Harvest

Bunches attain maturity from 100 to 150 days after flowering depending on variety, soil, weather condition and elevation.

Yield (t/ha/year)

Poovan	:	40 – 50
Monthan	:	30 – 40
Rasthali	:	40 – 50
Robusta	:	50 – 60
Dwarf Cavendish	:	50 – 60

Acid lime

Citrus aurantifolia (Christm) Swingle

Rutaceae

Varieties

PKM 1.

Soil and climate

Tropical and subtropical. Can be grown up to 1000 m above MSL. Deep well drained loamy soils are the best.

Season

December – February and June – September.

Planting

Healthy seedlings may be planted during June to December at 5 to 6 m spacing in 75 cm x 75 cm x 75 cm pits.

Irrigation

Irrigate copiously after planting. After establishment irrigation may be given at 7 – 10 days interval. Avoid water stagnation.

Manures and fertilizers per plant

N to be applied in two doses during March and October. FYM, P_2O_5 and K_2O are to be applied in October.

Manures and Fertilizers	I year (kg)	Annual increase (kg)	From 6th year (kg)
FYM	10.000	5.000	30.000
N	0.200	0.100	0.600
P_2O_5	0.100	0.025	0.200
K_2O	0.100	0.040	0.300

Spray Zinc sulphate at the rate of 0.5% (500 g/100 lit of water) thrice in a year (March, July and October) after the emergence of new flushes.

After cultivation

Remove branches of main stem up to 45 cm from ground level. Application of green leaves 30 kg per tree once in 3 months.

Intercropping

Legumes and vegetable crops can be raised during pre-bearing age.

Growth regulator

To increase fruit set spray 2,4 – D @ 20 ppm during flowering. For fruit retention spray 2,4 – D @ 20 ppm or NAA 30 ppm after fruit set (marble size).

Plant protection

Pests

Leaf miner

Spray Dichlorvos 76 WSC @ 1 ml/lit or Dimethoate 30 EC 2 ml/lit or Fenthion 100 EC @ 1 ml/lit or Monocrotophos 36 WSC @ 1.5 ml/lit or Neem Seed Kernel Extract (NSKE) 50g/lit or neem cake extract 5% or Neem oil 3ml/lit.

Leaf caterpillar

Spray Endosulfan 35 EC @ 2ml/lit when the infestation is moderate to severe. Hand pick the larvae and destroy.

Sucking pests

White fly : Spray Quinalphos 25 EC at the rate of 2 ml/lit

Black fly : Spray Monocrotophos 36 WSC at the rate of 1.5 ml/lit

Aphids : Spray Methyl demeton 25 EC or Monocrotophos at the rate of 1 ml/lit or neem oil 3ml/lit or Fish oil resin soap 30 g/lit. Endosulfan 35 EC 2ml/lit.

Rust mite : Spray dicofol 18 EC at the rate of 2.5 ml/lit or Wettable Sulphur 50 WP at the rate of 2 g/lit.

Fruit sucking moth

Destroy *Tinospora* weed host. Bait with fermented molasses plus Malathion 50 EC at the rate of 1 ml/lit. Bag the fruits with polythene bags punctured at the bottom. Apply smoke and set up light traps or food lures (pieces of citrus fruits).

Shoot borer

Prune the withered shoots 4 cm below the dried portions and spray Monocrotophos 36 WSC at the rate of 1 ml/lit or Endosulfan 35 EC at the rate of 1.5 ml/lit or Carbaryl 50 WP at the rate of 2 g/lit.

Stem borer

Prune the branches containing grubs. Plugging the fresh holes with cotton soaked in Monocrotophos solution mixed @ 5 ml/20 ml of water.

Fruit fly

Spray Malathion 50 EC @ 1 ml/lit or Fenthion 100 EC @ 1 ml/lit with 1% crude sugar (10 g/lit). Set up bait with Methyl Eugenol 0.1% solution mixed with Malathion 50 EC 0.05% between 6 a.m. and 8 a.m.

Mealy bugs

- Debark the branches and apply Methyl parathion paste.
- Use sticky trap on the shoot bearing the fruits at a length of 5 cm.
- Use Dichlorvos (0.2%) in combination with fish oil resin soap (25g/lit) as spray or for dipping the fruits for two minutes.
- Single soil application of Aldicarb 10G @ 50g per tree around the base at the time of pruning.
- Release the predator, *Cryptolaemus montrouzieri.*
- Mark the mealy bug infested plants early in the season.
- Put a band of diazenon 5g around the tree trunk leaving 30 cm from the main stem. Follow ant control methods such as destruction of ant holes, red ant nests and skirting of citrus trees after fruit harvest which prevent the ant migration through side branches.
- Release predatory beetles @ 10/tree once the patrolling of the ants on the trunk is stopped.
- Make periodic check during the first fortnight and put dried leaf mulch around the tree trunk 20 days after the release of the beetles to facilitate pupation of the full grown grubs.
- Make one to three releases per annum depending on the mealy bug populations.

Nematodes

Application of Carbofuran 3 G 75 g/tree to control citrus nematodes in severe infestations. Application of 20 g *Pseudomonas fluoresces* formulation per tree at a depth of 15 cm and 50 cm away from the trunk once in four months.

Diseases

Twig blight

Prune dried twigs and spray twice 0.1% Carbendazim followed by 0.3% Copper oxy chlorid and followed by 0.2% Foltaf at monthly interval.

Scab

Spray 1% Bordeaux mixture.

Canker

Immediately after pruning one spray of Copper oxychloride (COC) 0.3% followed by 4 sprayings with Streptocyclin100 ppm + 0.03% COC 0.3% at monthly interval.

Preharvest stem end rot

Four sprayings of Carbendazim 0.1% at monthly interval.

Tristeza virus

Remove the infected trees and destroy. Spray Methyl demeton 25 EC or Monocrotophos @ 1 ml/lit to control the aphids which spread the disease. Use pre-immunized acid lime seedlings for planting.

Harvest

Starts bearing from 3rd year after planting.

Post harvest treatment

Treating the fruits with 4% wax emulsion followed by pre-packing in 200 gauge polythene bags with 1 % ventilation improves the shelf life for more than 10 days.

Yield

25 t/ha/year.

Sweet orange

Citrus sinensis

Rutaceae

Varieties

Sathukudi

Soil and climate

Deep well drained loamy soils are the best for the cultivation of Citrus. pH of soil should

be 6.5 to 7.5 and EC of water less than 1.0. A dry climate with about 50 – 75 cm of rainfall from June – September with well defined summer and winter seasons is ideal. Comes up well in tropical zone below 500 m. Extremes of temperature are necessary.

Season

July to September.

Planting material

Budded plants. (Root stock-Rangpur lime is best, now rough lemon is also preferred).

Preparation of field

Dig pits at 75 cm x 75 cm x 75 cm size at 7 x 7 m spacing. Fill up the pits with top soil and 10 kg of FYM. Plant the budded plants in the centre of the pits and stake them.

Irrigation

Immediately after planting irrigate copiously. Irrigations may be given once in 10 days. Avoid water stagnation near the plant.

Manures and fertilizers per plant

N to be applied in two doses during March and October. FYM, P_2O_5 and K_2O are to be applied in October.

Manures and Fertilizers	I year (kg)	Annual increase (kg)	From 6th year (kg)
FYM	10.000	5.000	30.000
N	0.200	0.100	0.600
P_2O_5	0.100	0.025	0.200
K_2O	0.100	0.040	0.300

Manures are applied in the basin 70 cm away from the trunk and incorporated in the soil. Spray solution containing sulphate of zinc (0.5%), manganese (0.05%), iron (0.25%), magnesium (0.5%), boron (0.1%) and molybdenum (0.003%) once in 3 months at the time of new flush production. In addition to that apply 50 g in each of sulphate of zinc, manganese and iron per tree per year.

Plant protection

Leaf miner

Spray Dichlorvos 76 WSC at the rate of 1 ml/lit or Dimethoate 30 EC 2 ml/lit or Fenthion 100 EC at the rate of 1 ml/lit or Monocrotophos 36 WSC at the rate of 1.5 ml/lit or 5% of Neem Seed Kernel Extract (NSKE) or neem cake extract or Neem oil 3%.

Citrus root nematode

Apply *Pseudomonas fluorescens* at 20g per tree at a depth of 15 cm and 50 cm away from the trunk for the management of slow decline due to the citrus root nematode (*Tylenchulus semipenetrans*)

Little leaf malady

To control, spraying zinc sulphate at 1.0 per cent plus Teepol 1 ml/lit of solution at various stages.

1) new flush 2) one month after 3) at flowering and 4) fruit set

After cultivation

Remove water shoots, rootstock sprouts, dead and diseased shoots. Remove laterals upto 45 cm from ground level.

Intercropping

Legumes and vegetable crops can be raised during pre-bearing age.

Harvest

Starts bearing from 5th year after planting.

Yield

30 t/ha.

Mandarin orange

Citrus reticulata Blanco

Rutaceae

Varieties

Coorg Orange and Kodai Orange.

Soil and climate

Subtropical 500– 1500 m above MSL elevation. A rainfall of about 150 cm to 250 cm is required. The winter should be mild and there should be no strong, hot winds during summer. Deep well drained loamy soils are the best. Soil pH should be between 5.5 and 6.5.

Season

November – December.

Planting

Seedlings and budded plants.

Spacing

6 x 6 m, pit size 75 x 75 x 75 cm. Planting during May – June and September – October.

Manures and fertilizers (Apply twice in a year during June and October)

a) For Palani Hills

Manures & Fertilizers	I year	II year	III year	IV year	V year	VI year onwards
	Kg/plant/year					
FYM	10.000	15.000	20.000	25.000	25.000	30.000
N	0.100	0.200	0.300	0.400	0.500	0.600
P	0.040	0.080	0.120	0.160	0.160	0.200
K	0.050	0.100	0.200	0.300	0.300	0.400

b) For Shervarayan hills (for trees above 6 years old):

Apply 700:375:600 g/tree NPK along with VAM (*Glomus fasiculatum)* @ 1 kg/tree.

Manures are to be applied in the basin 70 cm away from the trunk and incorporated. Apply micronutrients as suggested for sweet orange. Apply agricultural lime or Dolomite at 4 kg/tree during January – February once in 2 – 3 years. This should not be combined with other chemical fertilizers.

Aftercultivation

Remove water shoots, rootstock sprouts, dead and diseased shoots. Remove laterals of the main stem up to 45 cm from ground level. Basins should be provided for each tree with gradient slope.

Plant protection

Pests

Leaf miner

Spray Dichlorvos 76 WSC at the rate of 1 ml/lit or Dimethoate 30 EC 1 ml/lit or Fenthion 100 EC at the rate of 1 ml/lit or Monocrotophos 36 WSC at the rate of 1.5 ml/lit or 5% of Neem Seed Kernel Extract (NSKE) or neem cake extract or Neem oil 3%.

Sucking pests

White fly : Spray Quinalphos 25 EC at the rate of 2 ml/lit

Black fly : Spray Monocrotophos 36 WSC at the rate of 1.5 ml/lit

Aphids	:	Spray Methyl Demeton 25 EC or Monocrotophos at the rate of 1 ml/lit or Neem oil 3 ml/lit or Fish oil resin soap 40 gm/lit. Endosulfan 35 EC 2 ml/lit.
Rust mite	:	Spray Dicofol 18 EC at the rate of 2.5 ml/lit or Wettable Sulphur 50 WP at the rate of 2 g/lit.

Fruit sucking moth

Destroy *Tinospora* weed host. Bait with fermented molasses plus Malathion 50 EC at the rate of 1 ml/lit. Bag the fruits with polythene bags punctured at the bottom. Apply smoke and set up light traps or food lures (pieces of citrus fruits).

Shoot borer

Prune the withered shoots 4 cm below the dried portions and spray Monocrotophos 36 WSC at the rate of 1 ml/lit or Endosulfan 35 EC at the rate of 1.5 ml/lit or Carbaryl 50 WP at the rate of 2 g/lit.

Stem borer

Prune the branches containing grubs. Plugging the fresh holes with cotton soaked in Monocrotophos solution mixed @ 5 ml/20 ml of water. Padding with Monocrotophos 2.5 ml + 2.5 ml of water

Fruit fly

Spray Malathion 50 EC @ 1 ml/lit or Fenthion 100 EC @ 1 ml/lit with 1% crude sugar (10 g/lit). Set up Methyl Eugenol 0.1% solution mixed with Malathion 50 EC 0.05% between 6 a.m. and 8 a.m.

Green scale

Spray Monocrotophos 36 WSC 1 ml/lit or Fenthion 100 EC 1 ml/lit. Spraying of fish oil rosin soap 40 g/lit. or Neem oil 3% or Endosulfan 35 EC 2 ml/lit.

Brown scale

Spray Monocrotophos 36 WSC 1 ml/lit.

Safe Waiting period Methyl demeton and Monocrotophos – 12 days.

Diseases

Powdery mildew

Apply sulphur dust 25 – 30 kg (350 mesh) in the early morning to protect new flush or spray Wettable Sulphur 0.5% (or) Bayleton 0.1% - 3 sprays at 15 days interval.

Sooty mould

Spray Phosphamidon 1 ml/lit. Boil 1 kg Maida or starch with 5 lit of water, cool, dilute to 20 lit and spray. Avoid spraying during cloudy weather.

Growth regulators

To increase the fruit retention spray the trees at flowering and again at marble stage with 2,4 - D at 20 ppm or NAA 30 ppm

Harvest

Starts bearing from 3 – 5 years after planting – budded plants, in case of seedlings 5-7 years.

Yield

15 – 20 t/ha/year

Grapes

Vitis vinifera

Vitaceae

Varieties

Muscat (Paneer), Pachadraksha, Anab-e-Shahi, Thompson Seedless, Arka Shyam, Arka Kanchan, Arka Hans, Manik Chaman, Sonaka, Sharadh Seedless and Flame Seedless.

Muscat is grown throughout Tamil Nadu except on the hills.

Soil and climate

Well drained rich loamy soil with a pH of 6.5 - 7.0 with low water table with EC less than 1.0. Soil depth should be atleast 1 m.

Field preparation and planting

Trenches of 0.6 m width and 0.6 m depth are to be dug at a distance of 3 m apart for Muscat and pits of 1m x 1m x 1m should be dug for other varieties. Well decomposed FYM or compost or green leaf manure has to be applied in the trenches or pits as the case may be and then covered with soil. Plant the rooted cuttings in June-July.

Spacing

3 x 2 m for Muscat, 4 x 3 m for other varieties.

Irrigation

Irrigate immediately after planting and on the 3rd day and then once in a week. Withhold irrigation 15 days before pruning and also 15 days before harvest.

Training

The vines are trained with single stem upto pandal with a stalk on tipping at 2 m height. The main arms are developed and trained on opposite directions. On further tipping, secondary and tertiary arms are developed for spreading all over pandal.

Pruning

In general four bud level of pruning for Muscat, Pachadraksha, Bangalore Blue, Anab-e-Shahi and Arka hybrids and two bud level for Thompson Seedless may be adopted. It is better to decide the level of pruning as per bud forecasting technique. Weak and immature canes should be pruned to one or two buds to induce vegetative growth.

Pruning Season

Summer crop

Pruning in December – January and harvesting in April – May.

Monsoon crop

Pruning in May-June and harvesting in August-September.

Manures and fertilizers (Kg per vine)

VARIETY	FYM			GREEN LEAVES			N			P			K		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Muscat	50	50	100	50	50	100	0.10	0.20	0.20	0.08	0.16	0.16	0.30	0.40	0.60
Pachadraksha Thompson Seedless	50	50	100	50	50	100	0.20	0.30	0.40	0.08	0.16	0.24	0.40	0.80	1.20
Sonaka Manikchaman Sharadh Seedless Anab-e-Shahi	50	50	100	50	50	100	0.20	0.40	0.60	0.08	0.16	0.24	0.40	0.80	1.20

The manures should be applied twice after pruning. Apply half the dose of potash immediately after pruning and the other half after 60 days of pruning.

Special practices

Tipping of shoots and tying of clusters in the pandal after the fruit set. Remove tendrils. Nipping the growing shoots of axillary buds and terminal buds at 12 to 15 buds. Thinning the compact bunches by removing 20 % of the berries at pea stage.

Plant protection

Pests

Nematodes

60 g of Carbofuran, 3 G of Phorate 10 G granules per vine are applied a week before pruning and the plots are irrigated profusely. The soil should not be disturbed for atleast 15 days. Thereafter normal manuring may be done. Application of neemcake 200 g/vine also controls nematodes. Alternatively application of *Pseudomonas fluorescens* formulation in talc containing 15 x 10^8 colony forming units/g, 30 cm away from base of the vine atleast 15 cm depth at the time of pruning.

Flea beetles

Spraying Phosalone 35 EC 2ml/lit of water after pruning and followed with two or three more sprayings. The loose bark may be removed at the time of pruning to prevent egg laying.

Thrips

Methyl Demeton 25 EC or Dimethoate 30 EC 2 ml/lit of water.

Mealy bug

Apply Quinalphos or Methyl parathion dust in the soil @ 20 kg/ha to kill the phoretic ants. Spray Methyl Demeton 25 EC or Monocrotophos 36 WSC at the rate of 2 ml/lit of water or spray Dichlorvos 76 WSC at the rate of 1 ml/lit with fish oil resin soap at 25 g/lit. Release Coccinellid beetle, *Cryptolaemus montrouzieri* at the rate of 10 per vine.

Stem girdler

Swab the trunk with Carbaryl 50 WP 2 gm/lit.

Safe waiting period

Five days for Dimethoate and Carbaryl.

Diseases

Powdery mildew

Spray 0.4% Wettable sulphur or dust Sulphur @ 6-12Kg/ha in the morning.

Anthracnose and downy mildew

Spray 1 % Bordeaux mixture or any other copper fungicide at 0.25 %. Depending upon the

weather conditions the sprays have to be increased.

Ripening

To get uniform ripening in Muscat, spray the bunches at 20th day after berry set and another spray on 40th day with 0.2% Potassium chloride (2 g/lit).

Dip the clusters of Thompson Seedless and other seedless varieties at calyptra fall with 25 ppm GA (25 mg/lit) and repeat again at pepper stage to increase the size of berries.

Yield

Seedless	:	15 t/ha/year
Muscat	:	30 t/ha/year
Pachadraksha	:	40 t/ha/year
Anab-e-Shahi and Arka hybrids	:	20 t/ha/year.

Preparation of 1% Bordeaux mixture

A quantity of 400 g of Copper sulphate should be dissolved in 20 lit of water and 400 g of burnt lime in another 20 lit of water separately. The copper sulphate solution should be added to the lime solution constantly stirring the mixture. Earthern or wooden vessels and plastic containers alone should be used and metallic containers should not be used. To find out whether the mixture is in correct proportion, a polished knife should be dipped in the mixture for one minute and taken out. If there is reddish brown deposit of copper, additional quantity of lime should be added till there is no deposit in the knife.

Guava

Psidium guajava **L.**

Myrtaceae

Varieties

Allahabad, Smooth Green, Lucknow 49 and Banaras.

Soil and climate

Guava grows well both in wet and dry regions but it does better under irrigation in the dry tracts. It can be grown upto 1000 m altitude. Well drained soils are the best. Tolerates salinity and alkalinity. In saline soils add 3 Kg Gypsum/plant during planting and once in three years after planting.

Planting material

Layers.

Season of planting

June - December.

Spacing

5 - 6m either way.

Planting

Plant the layers with the ball of earth in the centre of pit of 45 cm x 45 cm x 45 cm size filled with FYM 10 Kg, neem cake 1 Kg and top soil + 50 g Lindane 1.3%.

Irrigation

Irrigate copiously immediately after planting, again on third day and afterwards once in 10 days or as and when necessary.

Manures and fertilizers

FYM 50 Kg and one Kg in each of N, P and K per tree in two split doses during March and October. To increase the yield spray Urea 1 % + Zinc sulphate 0.5% twice a year during March and October. To correct the boron deficiency (reduction in size of leaves and fruit cracking and hardening) spray 0.3% borax during flowering and fruit set stage.

Micronutrients spray for controlling bronzing of leaves

Spraying of a combination spray containing $ZnSO_4$, $MgSO_4$ and $MnSO_4$ @ 0.5% and $CuSO_4$ and $FeSO_4$ @ 0.25 % plus Teepol @ 1ml per 5 lit of solution on various stages

1. new flush 2. one month after 3. flowering 4. fruit set

Intercropping

Legumes and short duration vegetable crops may be raised during pre-bearing stage.

Aftercultivation

Pruning of past season's terminal growth to a length of 10-15 cm is to be done during September-October and February – March to encourage more laterals. The erect growing branches are to be bent by tying on to pegs driven on the ground. Old unproductive but healthy trees may be either pollarded or cut the trunks at 75 cm from ground level or dehorned by cutting the secondary branches at a distance of 75 cm from their origin.

Plant protection

Pests

Tea mosquito bug

Spray Endosulfan 35 EC at the rate of 2 ml/lit or Fenthion 100 EC or Malathion 50 EC at the rate of 1 ml/lit or Monocrotophos 36 WSC @ 2ml/lit or Neem oil 3 %. Spraying should be done in early mornings or late evenings, at least four times at 21 days interval during fruiting season.

Aphids

Spray Monocrotophos 36 WSC @ 1ml/lit or Dimethoate 30 EC @ 2 ml/lit.

Mealy bug

Triazophos @ 2ml/lit + neem oil 5 ml or Phosalone 0.05% + neem oil 5 ml. Release of *Cryptolaemus montrouzieri* beetles (Coccinellid beetles) @ 10 beetles /tree.

Fruit fly

Remove the fallen fruits and bury them deeply with Lindane 1.3% dusted over them. Spray Endosulfan 35 EC or Malathion 50 EC @ 1 ml/lit four times at 15 days interval. Stir the soil around the tree during pest incidence and dust Lindane 1.3% at 25 kg/ha.

Safe waiting period

Monocrotophos 36 WSC-10 days and Malathion 50 EC – 9 days.

Diseases

Red rust

Spray Copper oxychloride 2.5 g/lit or Bordeaux mixture 0.5 % or Wettable sulphur 2 g/lit.

Harvest

Layers come to bearing in 2 - 3 years.

First crop : February – July.

Second crop : September – January.

Yield

25 t/ha.

Pineapple

Ananas sativus

Bromeliaceae

Varieties

Kew, Mauritius and Queen.

Soil and climate

Mild tropical climate as found in the humid hill slopes is best suited. Can be grown in plains under shade. Elevation from 500m to 700 m is ideal. A light well drained soil with pH 5.5 to 7.0 is preferable. Heavy soils can also be used if drainage facilities are available.

Spacing

Plant in double rows either in beds or in trenches with the plants into the second rows set in the middle of the plants in the first row.

The spacing between two trenches will be 90 cm. Row to row spacing in the same bed per trench will be 60 cm and plant spacing within the row is 30 cm.

Planting

Use suckers and slips of 300-350 g weight for planting. Give a slanting cut to the suckers before planting and dip in Mancozeb 0.3 % or Carbendazim 0.1%.

Season

July – September

Manures and fertilizers

FYM 40-50 t/ha. N 16 g, P 4 g and K 12 g/plant in two equal splits at 6th and 12th month after planting. Apply as foliar spray 0.5% - 1.0 % sulphate of Zinc and Ferrous solutions at 15 days interval to overcome the deficiencies in the early crop phase.

Aftercultivation

To have uniform flowering apply the following when the crop attains 35 – 40 leaf stage. NAA 10 ppm + 2 % urea (20 g in 1 lit of water) at 50 ml/plant poured into crown, or 2 % urea + 0.04 % Sodium carbonate + 20 ppm Ethephon (ethrel) at 50 ml/plant poured into the crown. To increase the size of the fruit, 200 – 300 ppm NAA should be sprayed after fruit formation. To avoid calcium induced iron chlorosis adequate shade should be given.

Plant protection

Mealy bug

Spray Methyl demeton 2 ml/lit or Monocrotophos 36 WSC 2 ml/lit.

Crop duration

18-24 months.

Harvest

Fruits can be harvested from 18 to 24 months. Slight colour change at the base of the fruit indicates maturity.

Yield

50 t/ha.

A plant crop and two ratoon crops are normally taken and in Mauritius variety upto five crops can be taken.

Sapota

Manilkhara achras

Sapotaceae

Varieties

Oval, Cricket Ball, Kirtibarti, Guthi, Co 1, Co 2, PKM 1, PKM 2, PKM 3 and Kalipatti.

Soil and climate

It is a tropical crop and can be grown up to an altitude of 1000 metres. It can be grown in all types of soils.

Planting materials

Grafted on *Manilkhara hexandra* (Pala) rootstock.

Season of planting

June to December

Spacing

8 x 8 m spacing.

Planting

Dig pits of 1 m x 1 m x 1 m size. Fill up with top soil mixed with 10 Kg of FYM, 1 Kg of neem cake and 100 g of Lindane 1.3%. Plant the grafts in the centre of the pit with ball of earth intact. The graft joint must be atleast 15 cm above the ground level. Stake the plants properly to avoid bending or damage to graft joint.

Irrigation

Irrigate copiously immediately after planting and on the third day and once in 10 days afterwards till the graft establishes.

Manures and fertilizers (Kg/tree)

Manures and Fertilizers	I year old	Annual increase	6th year onwards
FYM	10.000	10.000	50.000
N	0.200	0.200	1.000
P	0.200	0.200	1.000
K	0.300	0.300	1.500

Manures and fertilizers may be applied in September-October, 45 cm away from the trunk upto the leaf drip and incorporated.

Aftercultivation

Remove the rootstock sprouts, water shoots, criss-cross and lower branches.

Intercropping

Legumes and short duration vegetable crops may be raised as intercrop during pre-bearing stage.

Plant protection

Pests

Leaf webber

Spray Phosalone 35 EC 2 ml/lit.

Hairy caterpillars

Spray Chloropyriphos 30 EC or Endosulfan 35 EC or Phosalone 35 EC 2 ml/lit of water.

Bud worm

Spray Phosalone 35 EC 2 ml/lit or Phosphamidon 85 WSC 1 ml/lit or Endosulfan 35 EC 2 ml/lit or Carbaryl 50% 1 g/lit or Neem Seed Kernel Extract 5 %.

Diseases

Sooty mould

Boil 1 Kg maida or starch with 5 lit of water, cool and dilute to 20 lit and spray. Avoid spraying during cloudy weather.

Harvest

A mature fruit is dull brown in colour and the colour immediately below the skin when scratched is of lighter shade, while in the immature fruits it is green. The mature fruits are harvested by hand picking.

Season

February-June and September-October. Ripen the fruits by keeping a beaker containing 5000 ppm Ethrel + 10 g NaOH pellets in an air tight chamber. (5 ml Ethrel in one lit of water is 5000 ppm)

Yield

20-25 t/ha/year.

Papaya

Carica papaya L.

Caricaceae

Varieties

Co 1, Co 2, Co 3, Co 4, Co 5, Co 6 and Co 7.

Co 3 and Co 7 are gynodioecious (bisexual + female) types and Co 2, Co 5 and Co 6 are dual purpose varieties for table and papain production.

Soil and climate

It is a tropical fruit and grows well in regions where summer temperature ranges from 35°C - 38°C. Comes up to an elevation of 1200 m. Well drained soils of uniform texture are preferable. If drainage is not adequate, collar –rot disease may occur.

Sowing

500 g of seeds is required for planting one ha. June-September is the best season for planting. Avoid planting in rainy season.

Nursery

Treat the seeds with Captan @ 2 g/kg of seeds. Dibble four seeds in polythene bags in depth not exceeding one cm. Provide partial shade. Water the bags in rose can. Seedlings will be ready in about 60 days.

Planting

Plant the seedlings at 1.8 m either ways in pits of 45 cm x 45 cm x 45 cm size.

Irrigation

Irrigate copiously after planting. Irrigate the field once in a week.

Application of fertilizers

Apply FYM 10 Kg/plant as basal. Apply 50 g in each of N, P and K per plant at bi-monthly intervals from the third month of planting after removing unwanted sex forms. Apply 20 g each of *Azospirillum* and *Phosphobacterium* at planting and again six months after planting.

Aftercultivation

Male trees should be removed after the emergence of inflorescence maintaining one male tree for every 20 female trees for proper fruit-set. In each pit only one vigorously growing female/ hermaphrodite tree should be retained and other plants should be removed. In gynodioecious type like (Co 3, & Co 7) keep one hermophrodite type/pit and remove female trees.

Plant protection

Nematodes

To control in the nursery, apply Carbofuran 3 G @ 1 g/polythene bag after germination.

Diseases

Root rot and wilt

In water stagnated areas root-rot may appear. It is advisable to drench the soil with 0.1 % Methoxyethyl mercuric chloride or 1 % Bordeaux mixture or Metalaxyl 0.2%, 2 or 4 times at fortnightly intervals. Good drainage is vital.

Crop duration

24 – 30 months.

Harvest

Fruits should be picked at colour break stage.

Yield

The average yield is as follows

Co 2	:	200-250 t/ha
Co 3	:	100-120 t/ha
Co 5	:	200-250 t/ha
Co 6	:	120-160 t/ha
Co 7	:	200-225 t/ha.

Papain extraction

Papain has several industrial uses, the important one being in brewing industries. It is used as "meat tenderiser" and in textile and leather "sanforization" processes and drugs.

The method of extraction of papain from papaya fruits is simple. The latex should be tapped from immature papaya fruits. Select 75 to 90 days old fruits. On the selected fruit, give incisions (cut) with a razor blade or stainless steel knife. The cuts should be given from stalk to tip of the fruit. The depth of the cut should not be more than 0.3 cm. Four such cuts are given spaced equally on the fruit surface. Tap the latex early in the morning and complete the tapping before 10.00 a.m. Repeat the tapping four times on the same fruit at an interval of three days. The cut should be given on the fruit surface in places not covered by previous cuts. The latex collected from all the trees in a day should be pooled, shade dried in an aluminium pan or tray and passed through a 50 mesh sieve to remove all foreign matter. In large plantations, vacuum driers can be adopted with advantage. Papain produced by artificial heating will have better colour and high quality. Add potassium meta-bi-sulphite (KMS) at 0.5 % for better colour and keeping quality.

The latex should be dried very rapidly at temperatures of 50° to 55° C. Stop drying when the dried product comes off as flakes having a porous texture. Powder the dried papain by means

of wooden mallets or in electrically operated granulators and sieve the powder through 10 mesh sieve. Pack the powder in polythene bags in convenient quantities and seal them. Put the sealed bags in a tin container and seal it after evacuating air. Exposure to air deteriorates the quality of papain and vacuum sealing is therefore necessary. For large scale manufacture of papain, vacuum sealing machine and a granulator will be useful.

The green papaya fruits after extraction of papain can be used for pectin manufacture and "tooty – fruity" or they can be allowed to ripen and made into other products. The Co.2 and Co.5 varieties of papaya released by Tamil Nadu Agricultural University, Coimbatore are ideal for papain production. Tamil Nadu Agricultural University, Coimbatore, supplies pure seeds of these varieties.

Yield

The yield of crude papain is as follows:

Co 2 : 600 kg/ha

Co 5 : 800 Kg/ha.

Seed production technology

Germination improvement

Soak seeds in 100 ppm GA_3 for 16 hours or in 2% fresh leaf extract of arappu or 1% pungam leaf extract or pellet the seeds with arappu leaf powder.

Optimum depth of sowing

Sow seeds at 1 cm depth for better germination and seedling growth.

Seed extraction

Fruit size or weight has no association with seed quality except that the seed content is more in large fruits and less in small fruits. The seeds from different fruit weight or size classes do not differ in their quality. Hence, all ripened fruits can be used for seed extraction.

Grading

BSS 6 wire mesh sieve.

Storage

Dry seeds to 8-10% moisture and treat with halogen mixture containing $CaOCl_2$, $CaCo_3$ and arappu leaf powder (at 5:4:1 ratio) @ 3g/kg and pack in cloth bag to maintain viability upto 5 months.

Invigoration of old seeds

Stored seeds can be invigorated by soaking them in dilute solution of disodium phosphate (10^{-4}M) adopting 1:8 seed to solution ratio for 4 hours followed by drying back to original moisture content.

Pomegranate

Punica granatum L.

Punicaceae

Varieties

Jyothi, Ganesh, Co 1, YCD 1, Araktha, Rudhra and Mirudhula.

Soil and climate

It is grown in a wide range of soils; drought resistant and tolerant to salinity and alkalinity. Cool winter and dry summer are necessary for the production of high quality fruits. It performs well upto 1800 m elevation.

Planting

Rooted cuttings or layers of 12 to 18 months age can be planted during June to December in pits of 60 cm x 60 cm x 60 cm.at 2.5 to 3 m spacing either way.

Irrigation

Copious irrigation is essential during fruiting season.

Application of fertilizers: (per plant)

Manures and Fertilizers	Ist year	2nd to 5th year	6th year onwards
FYM	10 kg	20 kg	30 kg
N	200 g	400 g	600 g
P	100 g	250 g	500 g
K	400 g	800 g	1200 g

Training and pruning

Fruits are borne terminally on shoot growth emerging from mature wood. To promote new shoots on all sides annual pruning is done after harvest is completed during December by shortening of past season shoot by removing one third of the shoot. Besides, dried, diseased and criss-cross branches and root suckers are removed. The tree is trained to get a single stem upto 60 cm with 3 or 4 scaffold branches. Thinning of flower clusters ensures better size of the fruit. Spraying liquid paraffin at 1 % concentration at 15 days interval twice during June reduces fruit cracking.

Plant protection

Pests

Aphids

Release of first instar larvae of green lace wing bug *Chrysoperla carnea* @ 15 larvae/ flowering branch four times at 10 days interval starting from flower initiation during April.

Fruit Borer

1) Bag the fruits with polythene covers during flowering period to prevent egg-laying when the fruits are upto 5 cm diameter. Spray neem oil 3 % or NSKE 5% at the time of butterfly activity. Repeat it if necessary twice at an interval of 15 days.
2) Adopt ETL (5 eggs/plant with bearing capacity of 60 fruits)
3) Release egg parasite *T. chilonis* @ 1 lakh/acre.
4) Apply Endosulfan 35 EC 2 ml/lit; dimethoate 30 EC 1.5 ml/lit.

Yield

20-25 t/ha/year.

Jack

Artocarpus heterophyllus

Moraceae

Varieties

Velipala, Singapore, Hybrid jack, Panruti selection, Burliar 1, PLR 1 and PPI 1.

Soil and climate

Deep well drained soil is necessary. Comes up well in the plains and upto an elevation of 1200 m.

Preparation of field and planting

Dig pits of 1 m x 1 m x 1 m. Fill up the pits with top soil mixed with 10 Kg of FYM and 1 Kg of neem cake per pit. Apply Lindane 1.3% @ 100 g/pit and mix it thoroughly. Plant preferably grafts during June – December at 8 x 8 m spacing.

Irrigation

Once in a week till the plant is established. Thereafter irrigation as and when necessary.

Manures and fertilizers

To be applied in two splits during May - June and September - October.

Manures and Fertilizers	I year old	Annual increase	6th year and above
FYM	10.000	10.000	50.000
N	0.150	0.150	0.750
P	0.080	0.080	0.400
K	0.100	0.100	0.500

Plant protection

Pest

Spittle bug

Spray Methyl parathion 50 EC 2ml/lit. Dust Methyl parathion 2% or Quinolphos dust 1.5%. at 5 kg per medium sized tree. Spray Methyl demeton 25 EC 2ml/lit. Phosphamidon 85 WSC 1 ml/lit.

Diseases

Rhizopus rot

Spray 1 % Bordeaux mixture or Copper oxychloride 2.5 g/lit. three sprays at 15 days interval.

Harvest

Yield commences from 5th year in grafts and 8th year in seedling trees. Harvest during March-July.

Yield

30-40 t/ha.

Ber

Zizyphus mauritiana Lam

Rhamnaceae

Varieties

Kaithali, Umran, Gola and Banarasi.

Soil and climate

The ber plant comes under arid and semi-arid situation. Tolerates salinity and alkalinity.

Planting material

Budded plants.

Planting

Plant during July-August with a spacing of 7 x 7 m in pits of 60 cm x 60 cm x 60 cm. 8 x 3 m for Kaithali and 8 x 4 m for Banarasi.

Irrigation

Irrigate the plants initially for establishment. Provide 5 % slope towards the base of the tree for *in situ* water harvesting.

Manures and fertilizers (per plant/year)

Manures and Fertilizers	1st Year	2nd year onwards
FYM	20 kg	50 kg
N	200 g	500 g
P	100 g	200 g
K	200 g	500 g

Manuring to be given immediately after pruning.

Training and pruning

Remove the root stock sprouts and have a straight stem upto 75 cm from the ground level. It is very important in the early years to build up a strong framework and in later years to maintain vigour to improve fruit size and quality.

During February - March prune and thin the crowded branches to provide maximum fruit bearing area in the tree.

Plant protection

Pests

Fruit fly

Destroy infested fruits. Dig the soil under tree canopy to destroy pupae and incorporate Lindane 1.3% dust @ 30 g /tree. Spray Malathion 50 EC or Endosulfan 35 EC or Quinalphos 25 EC at 2 ml/lit.

Scale insects

During pruning all the affected materials should be collected and burnt. The trees should be sprayed with Phosphamidon 85 WSC or Methyl demeton 25 EC at the rate of 2 ml/lit.

Diseases

Black leaf spot

Spray Carbendazim 1 g/lit. or Chlorothalonil 2 g/lit. at 15 days interval from the initial appearance of the symptom.

Powdery mildew

Spray wettable sulphur 2 g/lit. or Dinocap 1 g/lit.

Yield

70-80 Kg of fruits/tree/year.

Seed production technology

Seeds of ber attain physiological maturity 13 weeks after anthesis. It is indicated by yellowish red colour of fruit pericarp. Stones can be size graded using 22/64" round perforated metal sieve. Ber stones can be stored upto 30 months without any treatment under ambient conditions.

Chapter B
Temperate Fruits

Apple

Malus sylvestris

Rosaceae

Varieties

Warm winter resistant varieties with low chilling requirements alone are suitable to the hills of Tamil Nadu.

Early varieties

Yield : April – May.
Irish Peach and Zouches Pipin.

Mid season varieties

Yield : June – July.

Carrington and Winterstein.

Late varieties

Yield : August – September.

Rome Beauty, Parlin's Beauty and KKL 1.

Soil and Climate

Red lateritic soils with good drainage and high organic matter are more suitable. The soil pH should be around 5.8 to 6.2. Can be grown from 1200 to 2000 m.

Planting material

One year old grafts on M.778 and M.779 rootstocks during June – July.

Season

June to December.

Spacing

4 x 4 m in pits of 60 cm x 60 cm x 60 cm.

Irrigation

Water the plants till establishment.

Application of fertilizer

Apply FYM 25 kg. N 500 g and 1 kg in each of P and K per bearing tree.

Training and pruning

The tree is trained to open centre system. Prune the tree every December – January.

Plant Protection

Pests

Wooly aphis

Use resistant rootstocks M 778, 799, MM 104, MM 110, MM 112, MM 113, MM 114 and MM 115.

The parasite *Aphelinus mali* should be conserved in the field. Spray Methyl demeton 25 EC at the rate of 4 ml/lit.

Disease

Apple scab

To control apple scabs follow the spray schedule:

1.	Silver tip to green tip	:	Captafol or Mancozeb or Captan 2 g/lit.
2.	Pink bud or after 15 days	:	Captan or Mancozeb 2 g/lit.
3.	Petal fall	:	Carbendazim 0.5 g/lit.
4.	10 days after petal fall	:	Captan or Mancozeb 2 g/lit.
5.	14 days after fruit set	:	Captafol 2 g/lit.

Add stickers like Triton AE or Teepol at 10 ml/10 lit of spray fluid. Use low volume sprayers.

Lichens

Spray quick lime 1 kg/20 lit of water after pruning to control lichens growth.

Yield

10 – 20 kg/tree/year. The tree starts bearing from 4th year of planting.

Pear

Pyrus communis L.

Rosaceae

Varieties

Common pear, Kieffer, New Pear, William and Jargonelle.

Soil and Climate

Red laterite soil with good drainage and high organic matter content. Can be grown at an elevation of above 1200 m. pH 5.8 to 6.2.

Planting material

Plant one year old grafts/rooted cuttings.

Planting season

June to December.

Spacing

5 x 5 m or 6 x 6 m in pits of 60 cm x 60 cm x 60 cm size.

Application of fertilizers

Apply FYM 25 kg, N 500 g and 1 kg in each of P and K per bearing tree/year.

Training and pruning

Remove stock sprouts regularly. Train the plants to open centre system and prune every year in November – December. Top working on country pear with choice varieties can be done during December - January with cleft grafting.

Plant protection

No serious pest and disease are noticed. Prophylactic spraying with a copper fungicides and Methyl demeton after pruning can be given.

Harvest

Early varieties will come to harvest in May – June and late varieties in July – October.

Yield

100 to 120 kg per tree per year in common pear.

70 to 80 kg per tree per year in Kieffer and New Pear.

30 to 40 kg per tree per year in William and Jargonelle.

Plum

Prunus salicina L.

Rosaceae

Varieties

Early

Rubio.

Mid-season

(June – July) - Hale, Gaviota and Abundance.

Late

(July – August) - Shiro, Kelsey and Satsuma.

Hale has to be planted along with other varieties to enhance pollination and fruit set.

Soil and Climate

Red lateritic soil with good drainage. The soil pH should be around 5.8 to 6.2 and rich in organic matter. Can be grown above 1200 m elevation.

Planting material

One year old budded plants may be planted during June - July or October - December with a spacing of 4 x 4 m in pits of 60 cm x 60 cm x 60 cm size.

Planting season

June to November.

Application of fertilizer

Apply FYM 30 kg and 500 g of N and 1 kg in each of P and K for bearing tree during October – November.

Training and pruning

The growing points tipped at a height of 50 – 60 cm to allow the side shoots to develop. Train to open centre system. Prune the trees during December – January. Dried, dead, diseased water shoots and criss-cross branches are removed.

Plant protection

Pests

Fruit Fly

Spray Malathion 50 EC at the rate of 2 ml/lit of Fenthion 100 EC at the rate of 1 ml/lit. Set up Methyl Eugenol 1 % trap with Malathion 50 EC 1 ml/lit between 6 a.m. and 8 a.m.

Yield

25 – 30 kg/tree/year.

Peach

Prunus persica

Rosaceae

Varieties

Early

(April – May) - Killikrankie and Floridasun.

Mid season

(June – July) - Shaw Pasand.

Late

(July – August) - Red Shanghai.

Soil and Climate

Red lateritic soil with good drainage and high organic matter is suitable. Grown at an elevation of 2000 m. Soil pH should be around 5.8 to 6.2.

Planting material

One year old budded plants.

Planting season

June – December.

Spacing

4 x 4 m in pits of 60 cm x 60 cm x 60 cm.

Manures and fertilizers

Apply FYM 25 kg. N 500 g and 1 kg in each of P and K per bearing tree.

Training and pruning

Train to open centre system. The trees are pruned annually during December – January. Dried, diseased, water shoots and criss-cross branches may be removed.

Plant protection

Lichens

Against lichens growth, spray 1 kg of quick lime/20 lit of water immediately after pruning.

Pests

Fruit Fly

Spray Malathion 50 EC at the rate of 2 ml/lit of water. Set up Methyl Eugenol 1 % trap with Malathion 50 EC 1 ml/lit between 6 a.m. and 8 a.m.

Diseases

Leaf curl

To control leaf curl aphids spray methyl dimeton 25 EC 2 ml/lit.

Spray Captan 2 g/lit. or Carbendazim 0.5 g/lit.

Powdery mildew

Spray Carbendazim 0.5 g/lit. or use Sulphur dust @ 25 kg/ha.

Yield

10 – 15 kg/tree/year.

Chapter C ☐ Minor Fruits

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
1	2	3	4	5	6	7	8	9	10
Mangosteen (*Garcinia mangostana*)	-	Seedlings	7 x 7 m	FYM, 75 kg N : 1 kg P : 0.8 kg & K : 3.0 kg/tree June - July.	Potting of plants at two leaf stage	-	April - June August - October	500 - 600 fruits/tree	-
Straw berry (*Fragaria vesca*)	Phenomenal, Majestic, Chandler, Labella, Sujatha	Runners/ Slips	40 x 25 cm (double row planting)	FYM : 3 kg/m² N:8g P:8g and K:8 g/plant, apply during October and February	Removal of flower buds till Jan. Mulching with dry grass	Spray Methyl demeton against mealy bugs and aphids. Spray Copper fungicides against leaf diseases	Harvest at three months after planting	1 kg/m² or 10 t/ha	
Passion fruit (*Passiflora edulis Sims.*)	Purple for hills, yellow for plains	Rooted cuttings or seedlings	2 x 2 m	FYM 10 kg, N 20 g, P 20 g and K 15 g/plant	Tying vine on trellies	Spray Methyl demeton against mealy bug and aphids	May - September	60 - 80 fruits/vine	Train on trellies or pandal.
Litchi (*Litchi chinensis Sonner.*)	Muzafarpur, Dehradun, Calcutta, seedless late and Rose scented Cauvery	Seedlings/ Budded plants/ layers	10 x 10 m	FYM : 60 kg N:100 g, P:40 g and K:400 g for 10 year old tree. Apply N in two split doses in Feb. & April. FYM, P and K to be applied in Dec.	If Zinc deficiency is present spray Zinc sulphate (0.5%)	Spray Kelthane against mites. Use fumigants against bark borers	Harvest from 6th year onwards	80 – 100 kg/tree	

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
Bilimbi (*Averrhoa bilimbi*)	-	Seedlings	-	N : 80 g P : 50 g K : 100 g/ bearing tree/year	-	-	-	50 kg/tree	-
Carambola (*Averrhoa carambola*)	Highly acidic, mild acidic	Seedlings	-	N : 100 g, P : 50 g and K : 100 g/ Plant	-	-	-	-	-
Karonda (*Carissa caranda*)	Green, pink, white	Seedlings & layers	2 x 2 m	FYM : 10 kg/ plant	Irrigation weekly	-	Aug-Sep	2 to 4 kg/tree	-
Amla (*Phyllanthus emblica*)	Banarasi, WA 7, Krishna, Kanchan, BSR 1	Seedlings, Grafts, Buddings	6 x 6 m	N : 200 g, P : 500 g and K : 200 g/ bearing tree	-	-	-	50 - 100 kg/tree annually	-
Loquat (*Eriobotrya japonica*)	Mammoth, Safed batia, Golden red, Tanaka, California, Advance, Pale yellow, Golden yellow	Seedlings/ Rooted cuttings/ Grafts/ Buddings	-	N : 50 g, P : 30 g, K : 150 g and Ca : 40 g per tree	-	-	Yield after third year	40 kg/tree	-
Jamun (*Eugenia jambolana*)	Local, Seedless, large	Seedlings/ grafts	10 x 10 m	FYM : 20 kg, N : 100 g, P : 100 g and K : 100 g/tree	-	100 g BHC 10 %/pit against white ants	Yield 8 - 10 years after planting, harvest in June - July	50 - 80 kg/tree	-

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
Phalsa (*Grewia asiatica*)	-	Seedlings/ Rooted Cuttings/ layers	2 x 2 m	N : 50 g, P : 20 g and K : 50 g/plant	Pruning at one m height; dormant during Dec - Jan. Irriga-tion once in 7 to 10 days in summer	-	Yield in third year pick ripe fruits on alternate days	2 - 3 kg/bush, fruits mature by May, June	-
Mulberry (*Morus nigra*)	Black mulberry	Seedlings/ Rooted cuttings/ Budlings	Pits by 0.5 x 0.5 m at 7 m apart	FYM : or Tank silt 10 kg, N:50g, P:50 g and K:50 g per plant	Pruning in December - January	-	-	4 - 8 kg/tree	-
West Indian Cherry (*Malphigia punicifolia*)	-	Seedlings/ grafts/layers/ rooted cuttings	2 x 2 m	FYM 10 kg, N:200 g, P:50 g and K:100 g/tree	Training and pruning	Spray Methyl demeton against mealy bugs and aphids	Harvest in Dec-Jan	10 - 15 kg/tree	-
Annona (*Annona squamosa;*) (*A.cherimnoya; A.reticulata*)	Balanagar, Mammoth, Atemoya	Seedlings/ grafts	5 x 5 m	FYM : 10 kg, neem cake one kg, BHC 10 % 100 g, N:250 g, P:125 g and K:250 g/tree	-	-	Yield after 4 - 5 years	80 - 100 Nos./tree	-
Lemon (*Citrus limon*)	Malta, Nepali oblong, Nepali round, Rajamundry, Lisbon, Willafranka, Italin, Eureka, Seedless, Seville Mayor	Layers	5 x 5 m	FYM:30 kg N 400 g, P : 200 g and K : 300 g/tree twice in a year	-	Spraying Zinc, Manganese, Iron, Magnesium at 0.125 %	Harvest 1 1/2 to 2 years after planting	50 kg/tree	-

Part II

Vegetables

Chapter A

Fruit vegetables

Tomato

Lycopersicon esculentum Mill.

Solanaceae

Varieties

Co 1, Co 2, Marutham (Co 3), PKM 1, Pusa Ruby and Paiyur 1.

Soil

Well drained loamy soils rich in organic matter.

Season of sowing and planting

May - June and November - February.

Seed rate

400 g per ha. Nursery area 100 sq.m.

Treat the seeds with fungicide 24 hours before sowing. Just before sowing treat the seeds with *Azospirillum* @ 40 g/400 g of seeds. Sow in lines at 10 cm apart in raised seed nursery beds and cover with sand.

Preparation of field

Plough the land to a fine tilth. Form ridges and furrows and transplant 25 days old seedlings on one side of the ridges. Apply 2 kg of *Azospirillum* per ha mixed with 20 kg FYM before planting.

Spacing

Co 1, Paiyur	:	60 x 45 cm
Co 2, PKM 1	:	60 x 60 cm
Co 3	:	45 x 30 cm

Irrigation

After establishment of seedlings irrigate at weekly intervals.

Application of fertilizer

Apply FYM 25 t/ha, N 75 kg, P 100 kg, K 50 kg, Borax 10 kg and Zinc sulphate 50 kg/ha as basal dose and 75 kg N/ha on 30th day of planting during earthing up. Spray 1 ppm (1 mg in one lit) Triacontanol, 15 days after transplanting and at full bloom stage to increase the yield.

Weed control

Apply Pendimethalin 1.0 kg a.i./ha as pre-emergence followed by one hand weeding on 30 days after planting.

Mulching

Lay Black LLDPE sheets of 25 micron thickness and bury both the ends into the soil to a depth of 10 cm.

Plant Protection

Pests

Fruit borer

Helicoverpa armigera and *Spodoptera litura* (Common for both)

Grow simultaneously 40 days old American tall marigold and 25 days old tomato seedlings @ 1:16 rows.

i. Set up pheromone traps @ 12/ha.

ii. Collection and destruction of damaged fruits and grown up caterpillars.

iii. Spray Endosulfan 35 EC 2 ml/lit or Carbaryl 50 WP 2 g/lit or *Bacillus thuringiensis* 2g/lit or Quinalphos 2.5 ml/lit.

iv. Release *Trichogramma chilonis* @ 50000/ha/release coinciding with flowering time and based on ETL.

For *Helicoverpa armigera:*

H.a.NPV 1.5 x 10^{12} PIB/ha

S.l. NPV 1.5 x 10^{12} PIB/ha

For *Spodoptera litura:*

Provide poison bait with Carbaryl 1.25 kg, rice bran 12.5 kg, Jaggery 1.25 kg and water 7.5 lit/ha.

Nematode

Application of Carbofuran 3 G at 10 g/sq.m at sowing and 1 kg a.i./ha in the main field one week after transplanting.

Serpentine leaf miner

Spray Neem Seed Kernel Extract 50 g/lit.

Diseases

Damping off (nursery)

Treat the seeds with *Trichoderma viride* 4 g/kg or Captan or Thiram at 2 g/kg of seeds 24 hours before sowing. Stagnation of water should be avoided. Drench with Copper oxychloride at 2.5 g/lit at 4 lit/sq.m.

Leaf spot

Spray Zineb or Mancozeb 2 g/lit.

Leaf curl

Spray systemic insecticides like Methyl demeton or Monocrotophos or Dimethoate at 2 ml/lit. to kill the insect vector, whitefly.

Tomato spotted wilt virus

Carbofuran 3 G 1 kg. a.i./ha in nursery at sowing and second application at 1.25 kg a.i./ha 10 days after transplanting in mainfield and 3 sprays of Endosulphan 35 EC 1.5 ml/lit @ 25, 40, 55 days after transplanting.

Yield

35 t/ha in 135 days.

COTH 1 HYBRID TOMATO

Season

May - June (Kharif), October - November (Rabi)

Seed Rate

150 g/ha

Seed Treatment

Treat the seeds with Captan or Thiram @ 2g/kg or *Trichorderma viride* @ 4g/kg of seeds 24 hours before sowing and with *Azospirillum* @ 20 g/150 g just before sowing.

Nursery

Prepare raised nursery beds with addition of organic manure + sand + red earth in equal proportions. Place the seeds individually in shallow furrows 10 cm apart or sow single seed in small poly cups. Pot water with rose can and drench the bed/container with Copper-Oxychloride at 2.5 g/l immediately after germination and again seven days later. Apply Carbofuran 3 G granules at sowing @ 10 g/sq.m.

Field preparation and planting

Thoroughly prepare the field with the addition of FYM @ 25 t/ha and form ridges and

furrows at a spacing of 60 cm. Apply 2 kg (10 packets) of *Azospirillum* per ha by mixing with 20 kg of FYM. Irrigate the furrows and transplant 25 days old seedlings, with the ball of earth, on the ridges adopting a spacing of 45 cm between the plants.

Manuring

Basal Dose : NPK 100:250:250 kg/ha; Borax 10 kg/ha and Zinc Sulphate 50 kg/ha.

Top dressing : N 100 kg in two splits at 30 and 60 days after planting.

Irrigation

Irrigate the field on the third day of planting and subsequently at weekly intervals.

After cultivation

a) Weeding and hoeing on 30th day and earth up.

b) Stake the plants 30 days after planting with 1 - 1.5 m tall stakes.

c) Remove the side branches up to 20 cm from ground level.

Plant protection

a) Apply Carbofuran 3 G granules 7 days after transplanting to control sucking pests/ vectors.

b) Spray Methyl demeton or Monocrotophos or Dimethoate 1 ml/l against thrips and whitefly.

c) Spray Endosulfan 2.5 ml/l or Carbaryl 2.5 g/l to control fruit borer.

d) Spray Zineb or Mancozeb 2 g/l to control leaf spot diseases.

Harvest

Harvest the fruits when they turn red.

Duration

110 - 115 days from transplanting (135 - 140 days from sowing).

Yield

96 t/ha.

Brinjal

Solanum melongena L.

Solanaceae

Varieties

Co 1, Co 2, MDU - 1 , PKM 1, PLR 1, KKM - 1 and Annamalai.

Soil

Well drained soil rich in organic matter.

Season of Sowing and planting

December – January and May – June.

Seed rate

400 g/ha. Nursery area 100 sq.m./ha.

Treat the seeds with *Trichoderma viride* @ 4 g/kg of seed or Captan or Thiram 2 g/kg of seed. Treat the seeds with *Azospirillum* at 40 g/400 g of seeds using rice gruel as adhesive. Irrigate with rose can. In raised nursery beds sow the seeds in lines at 10 cm apart and cover with sand. Transplant the seedlings 30 – 35 days after sowing at 60 cm apart in the ridges.

Preparation of Field

Plough the field to a fine tilth. Apply FYM or compost at the last ploughing and form ridges and furrows at 60 cm apart. Pre-emergence application of Pendimethalin @ 1.0 kg a.i per ha is recommended.

Irrigation

After establishment irrigate at weekly intervals.

Application of fertilizers

Apply FYM 25 t/ha. N 50 kg, P 50 kg and K 30 kg/ha as basal dose, N 50 kg/ha 30 days after transplanting during earthing up. Apply 2 kg each of *Azospirillum* and *Phosphobacterium* in the mainfield at planting. Spray 2 ppm (1 ml in 500 lit) Triacontanol plus Sodium Borate or Borax 35 mg/lit of water 15 days after transplanting and at the time of full bloom to increase the yield.

Plant protection

Pests

Nematodes and Damping off disease

Seed treatment with antagonistic fungi viz., *Trichoderma harzianum* 4g/kg seed and *T.viride* 4 g/kg seed along with application of press mud at 5kg/m^2 or Carbonfuran 3gat 10g/m^2

Epilachna beetle

Collect the beetles, grubs, pupae and destroy. Spray Carbaryl 50% WP 2 g/lit or Endosulfan 35 EC 2 ml/lit.

White fly

Monitor the white fly with yellow sticky trap at 12 no/ha. Spray Neem oil 3 ml/lit of water plus Teepol (1 ml/lit) or spray Neem Seed Kernal Extract 50 g/lit.

Shoot & Fruit borer

Remove the affected terminal shoot showing bore holes. Remove the affected fruits and

destroy. Spray any one of the following chemicals starting from one month after planting at 15 days interval.

1. Carbaryl 50% WP 2 g/lit + Wettable Sulphur 50% WP 2 g/lit.
2. Endosulfan 35 EC 2 ml/lit + Neem oil 2 ml/lit.
3. Quinalphos 25 EC 2 ml/lit + Neem oil 2 ml/lit.
4. Neem Seed Kernel Extract 50 g/lit.
5. Avoid using synthetic pyrethroids.

Ash Weevil

Apply Carbofuran 3 G at 15 kg/ha 15 days after planting.

Aphid

Methyl demeton 25 EC 2 ml/lit or Dimethoate 30 EC 2 ml/lit. Release 1st instar larvae of Green Lace Wing Bug (*Chrysoperla cornea*) @ 10,000 per ha.

Red Spider mite

Spray Dicofol 3 ml/lit or Wettable Sulphur 50 % WP 2 g/lit.

Diseases

Damping off

Treat the seeds with *Trichoderma viride* at 4 g/kg or Captan or Thiram at 2 g/kg of seeds 24 hours before sowing. Drench nursery with Copper oxychloride 2.5 g/lit at 4 lit/sq.m.

Leaf Spot

Spray Mancozeb 2 g/lit.

Little Leaf

Remove the affected plants in the early stages and spray Methyl demeton 25 EC 2 ml/lit or Dimethoate 30 EC 2 ml/lit. to control the vector.

Yield

25 to 30 t/ha in 150 – 160 days.

Bhendi

Abelmoschus esculentus (L) Moench.

Malvaceae

Varieties

Co 1, MDU 1, Arka Anamika, Arka Abhay, Parbhani Kranti and Co 3 (hybrid), Varsha Uphar.

Soil and climate

It is adaptable to a wide range of soils from sandy loam to clayey loam. It requires a warm climate during growing season.

Season and sowing

June - August and February - March.

Seed rate

7.5 kg/ha

Seed treatment with Captan or Thiram at 2 g/kg of seed 24 hours before sowing, the seeds are again treated with 400 gm of *Azospirillum* using starch as adhesive and dried in shade for 20 minutes. Sow three seeds per hill at 30 cm apart and then thin to 2 plants per hill after 10 days.

Preparation of field

Plough the land 4 - 5 times and form ridges and furrows at 45 cm apart.

Irrigation

After germination, irrigate at weekly intervals.

Application of Fertilizers

Apply FYM 25 t/ha, N 20 kg, P 50 kg and K 30 kg/ha as basal and 20 kg N/ha 30 days after sowing. Apply *Azospirillum* and *Phosphobacterium* each at 2 kg/ha mixed in 20 kg of FYM before sowing.

Foliar nutrition

1) Spray 1 % urea (10 g/lit) 3 times at 10 days interval from 20 days after sowing.
2) Spray Muriate of Potash (17 g/lit) on 30, 45 and 60th day of sowing.

Weed control

Spray Oxyflourfen at 1.25 l/ha or Fluchloralin at 2 l/ha or Metolachlor at 1.5 l/ha as per-emergence application on third day after sowing. Herbicide application should be integrated with one hand weeding on 30 days after sowing.

Plant protection

Pests

Fruit borer

Integrated Pest management

Spray Carbaryl 50% WP 2 g/lit. or Endosulfan 35 EC 2 ml/lit. or Monocrotophos 35 WSC 2 ml./lit. combined with or Neem Seed Kernel Extract 50 g/lit.

1. Set up pheromone trap for *Earias sp.* at 12/ha.

2. Collection and destruction of affected fruits.
3. Release of egg parasite *Trichogramma* at 1.0 lakh/ha.
4. Release of 1st instar larvae of green lace wing bug *Chrysoperla carnea* @ 10,000/ha.
5. Spray *Bacillus thuringiensis* 2 g/lit.

Leaf hopper

Monocrotophos 36 WSC 2 ml./lit. Dimethoate 30 EC 2 ml/lit combined with Neem Seed Kernal Extract 50 g/lit.

Nematode

Application of Carbofuran 3 G 1 kg a.i /ha or Phorate 10 G 1 kg a.i./ha and Neem cake 400 kg/ha at sowing in furrows along with fertilizers.

Diseases

Yellow vein mosaic virus

Spray Monocrotophos 2 ml/lit to kill the vector i.e., white flies.

Powdery mildew

Dust Sulphur 25 kg/ha or spray Dinocap 2 ml/lit/ or Tridemorph 0.5 ml/lit or Carbendazim 1 g/lit or Wettable sulphur 2 g/lit immediately after noticing the disease and repeat after 15 days.

Yield

12 - 15 t/ha in 90 - 100 days.

Chillies

Capsicum annuum L.

Solanaceae

Varieties

K 1, K 2, Co 1, Co 2, Co 3, PKM 1, PMK 1 (for semi-dry conditions in Southern Districts) and PLR 1 (for coastal regions of North - East Tamil Nadu).

Soil

Well drained loamy soils rich in organic matter.

Season of sowing and planting

1) January - February
2) June - July
3) September

Seed rate

1.0 kg/ha.

Nursery area: 100 sq.m/ha.

Treat the seeds with *Trichoderma viride* @ 4 g/kg or fungicides Thiram or Captan at 2 g/kg and sow in lines spaced at 10 cm in raised nursery beds and cover with sand. Watering with rose can has to be done daily. Drench the nursery with Copper oxychloride at 15 days interval against damping off disease. Apply Carbofuran 3 G at 10 g/sq.m. at sowing.

Preparation of field

Plough the land to a fine tilth. Form ridges and furrows 45 cm apart. Transplant 40-45 days old seedlings at 30 cm spacing. Adapt 30 x 15 cm for Co 3 Chillies in flat beds.

Irrigation

After establishment of seedlings, irrigate at weekly intervals.

Application of fertilizers

Apply FYM 25 t/ha. N 30 kg; P 60 kg and K 30 kg/ha as basal and 30 kg N/ha each on 30, 60 and 90 days of planting.

Weed control

Spray Fluchloralin 1 lit a.i/ha as pre-emergence and may be combined with one hand weeding and earthing up on 45 days after planting. Raise intercrop of onion in paired row system to get additional income.

Growth regulator

Spray NAA 10 ppm (10 mg/lit of water) on 60 and 90 days after planting to increase fruit set. Spray Triacontanol at 1.25 ppm (1.25 ml/lit) on 20, 40, 60 and 80th day of planting.

Plant protection

Pests

Fruit borer

Integrated pest management of fruit borer:

1. Set up pheromone traps for *Helicoverpa armigera/Spodoptera litura* at 12 No/ha.
2. Collection and destruction of damaged fruits and grown up caterpillars.
3. Spray *Bacillus thuringiensis* at 2 g/lit.
4. Provide poison bait with Carbaryl 1.25 kg, rice bran 12.5 kg, jaggery 1.25 kg and water 7.5 lit/ha.
5. Spray Carbaryl 50 WP 3 g/lit/ or Chlorpyriphos 20 EC 3 ml/lit or Quinalphos 25 EC 2.5 ml/lit.

Thrips

Spray Dimethoate 30 EC 2 ml/lit or Methyl demeton 25 EC 2 ml/lit or Formothion 2 ml/lit or dust Quinalphos 1.5 D at 20 kg/ha thrice at fortnightly intervals.

Aphids

Acephate 75 S.P. 1 g/lit or Methyl demeton 25 EC 2 ml/lit or Phosalone 35 EC 2 ml/lit.

Yellow Muranai mite

Spray Dicofol 18 EC 3 ml/lit or Ethion 50 EC 4 ml/lit or Wettable sulphur 50 WP 6 g/lit.

Diseases

Damping off

Treat the seeds with *Trichoderma viride* at 4 g/kg or Captan or Thiram at 2 g/kg of seeds 24 hours before sowing. Drench nursery with Copper oxychloride 2.5 g/lit at 4 lit/sq.m.

Leaf spot

Spray Mancozeb 2 g/lit or Copper oxychloride 2.5 gm/lit.

Powdery mildew

Spray Wettable sulphur 2 g/lit or Carbendazim 1 g/lit, 3 sprays at 15 days interval from the first appearance of symptom.

Die-back and fruit rot

Spray Mancozeb 2 g/lit or Copper oxychloride 2.5 g/lit. thrice at 15 days interval starting from noticing the die-back symptoms.

Chilly mosaic

Raise 2 rows of maize or sorghum for every 5 rows of chilli crop against wind direction. Spray recommendations given for aphids may be adopted for controlling the vector.

Yield

2 - 3 t/ha of dry pods or 10 - 15 t/ha of green chillies in 210 - 240 days.

Paprika

Capsicum sp

Solanaceae

Varieties

KTPL-19, SB 106.

Soil

Well-drained sandy loam or clay saline free soil is preferable. It can be grown on any fertile well-drained soil suitable for chillies cultivation with pH 6.5 - 7.0.

Season

June - July.

Seed rate

500 g/ha.

Nursery

Prepare 10 - 12 beds of 7 m long 1.2 m wide and 15 cm height and sow the seeds in rows 6 cm apart on 0.5 cm deep. Apply 15 - 20 kg well decomposed compost and 500 g of 15:15:15 NPK complex fertiliser to each bed 15 to 20 days before sowing.

Transplanting

Healthy seedlings may be transplanted at a spacing of 45 cm apart.

Application of fertilisers

Apply 20 - 25 tonnes/ha FYM, 60, 100 and 60 kg NPK/ha as basal, 20 kg N and 20 kg K 3 weeks after transplanting. 40 kg N and 40 kg K/ha 6 weeks after transplanting.

Plant protection

Pest

Fruit borer

Spray Endosulfan 2 ml/lit.

Diseases

Anthracnose

Spray Mancozeb 2 g/lit.

Fruit rot

Spray Copper oxy chloride @ 2.5 g/lit.

Powdery mildew

Spray Wettable sulphur @ 0.3%

Yield

25 - 35 t/ha.

Pumpkin

Cucurbita moschata Poir.

Cucurbitaceae

Varieties

Co 1, Co 2, Arka suryamuki and Arka Chandan.

Soil and climate

Sandy loam rich in organic matter and with good drainage. The crop requires a moderate warm temperature.

Season and sowing

July and January.

Soak the seeds in double the quantity of water for 30 minutes and incubate for 6 days. Sow the seeds (5 seeds/pit) treated with Thiram or Captan (2 g/kg of seed) 24 hours before sowing and *Azospirillum* just before sowing and thin the seedlings to two per pit after 15 days.

Seed rate

1.0 kg/ha.

Spacing

2 m x 2 m. Pit size 30 cm x 30 cm x 30 cm.

Application of fertilizers

Apply 10 kg of FYM (20 t/ha) and 100 g of NPK 6:12:12 g as basal and 10 g of N per pit after 30 days of planting.

Aftercultivation

Hoe and weed thrice. Spray Ethrel 250 ppm (2.5 ml per 10 lit of water) four times at weekly intervals commencing from 10 to 15 days after sowing.

Plant protection

Pests and diseases

Beetles and caterpillars

Spray Malathion 50 EC 1 ml/lit. or Dimethoate 30 EC 1 ml/lit. or Methyl demeton 25 EC 1 ml/lit. or Fenthion 100 EC 1 ml/lit.

Fruit fly

1) Collect the damaged fruits and destroy.
2) The fly population is low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.

3) Plough the field to expose the pupae.

4) Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml. Dichlorvas in cotton. 50 traps are required/ha, fish meal + Dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

Do not use DDT, Lindane 1.3% dust, Copper and Sulphur dust. These are phytotoxic.

Diseases

Powdery mildew

Spray Dinocap 1 ml/lit. or Carbendazim 0.5 g/lit.

Downy mildew

Spray Mancozeb or Chlorothalonil 2 g/lit. twice at 10 days interval.

Yield

20 t/ha in 140 days.

Snake gourd

Trichosanthes cucumerina. L

Cucurbitaceae

Varieties

Co 1, Co 2, PKM 1 and MDU 1.

Soil and climate

Sandy loam rich in organic matter and with drainage. The crop requires a moderate warm temperature.

Season and sowing

July and January.

Sow the seeds (5 seeds/pit) treated with Thiram or Captan (2 g/kg of seed) and thin the seedlings to two per pit after 15 days.

Seed rate

1.5 kg/ha.

Preparation of field

Plough the field to fine tilth. Dig pits of size 30 cm x 30 cm x 30 cm at 2.5 x 2 m spacing and form basins.

Irrigation

Irrigate the basin before dibbling the seeds and thereafter once a week.

Application of fertilizers

Apply 10 kg of FYM, 100 g of NPK 6:12:12 as basal per pit and N @ 10 g pit 30 days after sowing.

Aftercultivation

Hoe and weed thrice. Provide stakes to reach the pandal height (2 m). Pandal is not essential for Co 2 variety. Spray Ethrel 100 ppm (1 ml in 10 lit of water) four times from 10 to 15 days after sowing at weekly intervals.

Plant protection

Pests

Leaf Beetles, and Leaf caterpillars

Spray Malathion 50 EC 1 ml/lit or Dimethoate 30 EC 1 ml/lit or Methyl demeton 25 EC 1 ml/lit or Fenthion 100 EC 1 ml/lit.

Fruit fly

1. Collect the damaged fruits and destroy.
2. The fly population is low in hot day conditions and it is peak in rainy season. Hence, the sowing time may be adjusted accordingly.
3. Expose the pupae by ploughing.
4. Use 20 x 15 cm poly bags fish meal traps with 5 g of fish meal + 1 ml of Dichlorvos in cotton @ 50 traps/ha. Fish meal and cotton are to be removed once in 20 and 7 days respectively.

Do not use DDT, Lindane 1.3% dust, Copper and Sulphur dust. These are phytotoxic.

Diseases

Powdery mildew

Spray Dinocap 1 ml/lit or Carbendazim 0.5 g/lit.

Downy mildew

Spray Mancozeb or Chlorothalonil 2 g/lit twice at 10 days interval.

Yield

18 t/ha in 135 – 145 days.

Ribbed gourd

Luffa acutangula Roxb.

Cucurbitaceae

Varieties

Co 1, Co 2 and PKM 1.

Soil and climate

Sandy loam rich in organic matter and with drainage. The crop requires a moderate warm temperature.

Season and sowing

July and January.

Seed rate

1.5 kg/ha. Sow the seeds (5 seeds/pit) treated with Thiram or Captan (2 g/kg of seed) and thin the seedlings to two per pit after 15 days.

Preparation of field

Plough the field to fine tilth. Dig pits of 30 cm x 30 cm x 30 cm size at 2.5 x 2 m spacing and form basins.

Irrigation

Irrigate the basin before dibbling the seeds and thereafter once in a week.

Application of fertilizers

Apply 10 kg of FYM, 100 g of NPK 6:12:12 gm mixture as basal per pit and N @ 10 g per pit 30 days after sowing.

Aftercultivation

Hoe and weed thrice and provide support for the plants to reach the pandal erected at a height of 2 m. Spray Ethrel 250 ppm (2.5 ml/10 lit of water) four times commencing from 15th day after sowing at weekly intervals to increase yield.

Plant protection

Pests and diseases

Beetles, fruit flies and caterpillars

Spray Malathion 50 EC 1 ml/lit. or Dimethoate 30 EC 1 ml/lit. or Methyl demeton 25 EC 1 ml/lit. or Fenthion 100 EC 1ml/lit.

Do not use DDT, Lindane 1.3% dust, Copper and Sulphur dust as these are phytotoxic.

Powdery mildew

Spray Dinocap 1 ml/lit. or Carbendazim 0.5 g/lit.

Downy mildew

Spray Mancozeb or Chlorothalonil 2 g/lit. twice at 10 days interval.

Yield

14 – 15 t/ha in 125 days.

Bottle gourd

*Lagenaria siceraria (*Mol) Standl.

Cucurbitaceae

Varieties

Co 1, Pusa Summer Prolific Long, Pusa Summer Prolific Round, Pusa Manjari, Pusa Megadoot and Arka Bahar.

Soil and climate

Sandy loams rich in organic matter and with good drainage. The crop requires a moderate warm temperature.

Season and sowing

July and January. Sow the seeds (5 seeds/pit) treated with Thiram or Captan (2 g/kg of seed) and thin the seedlings to two per pit after 15 days.

Seed rate

3 kg/ha..

Preparation of field

Plough the field to fine tilth. Dig pits of the 30 cm x 30 cm x 30 cm size at 2.5 x 2 m spacing.

Irrigation

Irrigate the field before dibbling the seeds and thereafter once a week.

Application of fertilizers

Apply 10 kg of FYM (20 t/ha) 100 g of NPK 6:12:12 mixture as basal and 10 g of N per pit 30 days after sowing.

Aftercultivation

Hoe and weed thrice.

Plant protection

Pests

Beetles, fruit flies and caterpillars

Spray Malathion 50 EC 1 ml/lit. or Dimethoate 30 EC 1 ml/lit. or Methyl demeton 25 EC 1 ml/lit. or Fenthion 100 EC 1 ml/lit.

Do not use DDT, Lindane 1.3% dust, Copper and Sulphur dust as these are phytotoxic.

Powdery mildew

Spray Dinocap 1 ml/lit. or Carbendazim 0.5 g/lit.

Downy mildew

Spray Mancozeb or Chlorothalonil 2 g/lit. twice at 10 days interval.

Yield

15 – 20 t/ha in 135 days.

Bitter gourd

Momordica charantia L.

Cucurbitaceae

Varieties

Co 1, MDU 1, Arka Harit, Priya and Preethi.

Soil and climate

Sandy loam rich in organic matter and with good drainage. The crop requires a moderate warm temperature.

Season and sowing

July and January.

Sow the seeds (5 seeds/pit) treated with Thiram or Captan (2 g/kg of seed) and thin the seedlings to two per pit after 15 days.

Seed rate

4.5 kg/ha.

Preparation of field

Plough the field to fine tilth. Dig pits of 30 cm x 30 cm x 30 cm size at 2 x 1.5 m spacing and form basins.

Irrigation

Irrigate the basins before dibbling the seeds and thereafter once a week.

Application of fertilizers

Apply 10 kg of FYM per pit (20 t/ha) 100 g of NPK 6:12:12 per pit as basal and 10 g of N per pit 30 days after sowing.

Aftercultivation

Hoe and weed thrice. Provide stakes to reach the pandal (2 m). Spray Ethrel 100 ppm (1 ml dissolved in 10 lit of water) four times from 15th day after sowing at weekly intervals.

Plant protection

Pests and diseases

Beetles, fruit flies and caterpillars

Spray Malathion 50 EC 1ml/lit or Dimethoate 30 EC 1ml/lit or Methyl demeton 25 EC 1ml/lit or Fenthion 100 EC 1ml/lit.

Do not use DDT, Lindane 1.3% dust, Copper and Sulphur dust, as these are phytotoxic.

Powdery mildew

Spray Dinocap 1ml/lit or Carbendazim 0.5 g/lit.

Downy mildew

Spray Mancozeb or Chlorothalonil 2 g/lit twice at 10 days interval.

Yield

14 t/ha in 140 - 150 days.

Ash gourd

Benincasa hispida Cogn.

Cucurbitaceae

Varieties

Co 1 and Co 2.

Soil and climate

A deep loamy soil is suitable. A warm tropical climate is ideal.

Season and sowing

July and January.

Five to six seeds are sown in each pit and after germination, the seedlings are thinned to two per pit.

Seed rate

2.5 kg/ha. Soak the seeds in double the quantity of water for 30 minutes and incubate for 6 days.

Preparation of field

Plough the field 3 – 4 times. Dig pits of 30 cm x 30 cm x 30 cm at a spacing 2 x 1.5 m and form basins.

Irrigation

Irrigate the basin before dibbling the seeds and thereafter once in a week.

Application of fertilizers

Apply 10 kg FYM per pit and 100 g of NPK 6:12:12 mixture/pit and 10 g N/pit 30 days after sowing.

Aftercultivation

Hoe and weed thrice. Spray Ethrel 250 ppm (2.5 ml/10 lit of water) four times at weekly intervals commencing from 15th day after sowing.

Plant protection

Pests

Leaf Beetles, and Leaf caterpillars

Spray Malathion 50 EC 1 ml/lit or Dimethoate 30 EC 1 ml/lit or Methyl demeton 25 EC 1 ml/lit or Fenthion 100 EC 1 ml/lit.

Fruit fly

1. Collect the affected fruits and destroy.
2. The fly population is low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.
3. Expose the pupae by ploughing.
4. Use polythene bags, fish meal trap with 5 gm of wet fish meal and 1 g of Dichlorvos in cotton, 50 traps are required per hectare. Fish meal and Dichlorvos impregnated

cotton are to be renewed once in 20 and 7 days respectively.

Do not use DDT, Lindane 1.3% dust, Copper and Sulphur dust, as these are phytotoxic.

Diseases

Powdery mildew

Spray Dinocap 1 ml/lit or Carbendazim 0.5 gm/lit.

Downy mildew

Spray Mancozeb or Chlorothalonil 2 g/lit twice at 10 days interval.

Yield

20 t/ha in 140 days.

Cucumber

Cucumis sativus L.

Cucurbitaceae

Varieties

Co 1, Japanese Long Green, Straight Eight and Poinsettee.

Soil and Climate

Sandy loam rich in organic matter and with good drainage. The crop requires a moderate warm temperature.

Preparation of field

Plough the field four times. Form long channels at 1.5 m apart.

Season and sowing

Sow the seeds during June or January to April at 2.5 kg/ha after treating with Thiram or Captan (2 g/kg of seeds) on one side of channel giving a spacing of 0.6 m between hills. Thin the seedlings to two per hill.

Irrigation

Irrigate the field before dibbling the seeds and thereafter once a week.

Application of fertilizers

Apply FYM 40 t/ha as basal and 35 kg of N/ha at 30 days after sowing.

Aftercultivation

Hoe and weed twice or thrice.

Plant protection

Diseases

Powdery mildew

Spray Dinocap 0.5 ml/lit or Carbendazim 0.5 g/lit.

Do not use DDT, Lindane 1.3% dust, Copper and Sulphur dust, as these are phytotoxic.

Yield

8 – 10 t/ha in 80 to 90 days for salad.

Gherkin

Varieties

Calypso hybrid.

Soil

Comes up well in wide range of soils. Well-drained sandy loam with a pH range of 6.0 to 6.8 is optimum.

Season

Warm season crop requiring a moderately high temperature.

Seed rate

800 g per hectare.

Sowing

Sow the seeds at 30 cm spacing on sides of the ridges with 2 seeds per hill.

Preparatory cultivation

Apply 25 t/ha of FYM. Prepare ridges and furrows one metre apart.

Manuring

Apply N - 150 kg, P - 75 kg and K - 100 kg/ha in 3 equal splits i.e., basal, three and five weeks after sowing.

Aftercultivation

Earth up the plants 25 days after sowing. Provide support to plants as and when vines start trailing.

Plant protection

Minor pest

For Leaf miner, white fly, aphids and thrips spray Dimethoate 1.5 ml/lit or Monocrotophos 1.5 ml/lit or Malathion 1.5 ml/lit.

Diseases

Spray Carbendazim 0.05 % (0.5 g/lit) to control diseases.

Yield

10 - 12 tonnes/ha in 90 days.

Watermelon

Citrullus lanatus (Thumb) Matsum and Nakai

Cucurbitaceae

Varieties

PKM 1, Sugar Baby, Arka Manik, Arka Jyoti (F1 hybrid) and Pusa Bedana (F1 hybrid).

Soil and climate

Sandy loam rich in organic matter and with good drainage. The crop requires a moderate warm temperature.

Season and sowing

Sow the seeds during January – February at 3.5 kg/ha after treating with Thiram or Captan (2 g/kg of seed) on one side of the channel with a spacing of 0.9 m between hills. Thin the seedlings 2 per hill 15 days after sowing.

Preparation of field

Plough the field to a fine tilth and form long channel 2.5 m apart.

Irrigation

Irrigate the field before dibbling the seeds and thereafter once a week.

Application of fertilizers

Apply FYM 20 t/ha, P 55 kg and K 55 kg as basal and N 55 kg/ha 30 days after sowing.

Aftercultivation

Spray ethrel 250 ppm (2.5 ml/10 lit of water) 4 times at weekly intervals commencing from 15 days after sowing. Hoe and weed thrice.

Plant protection

Pests

Beetles and Fruit fly

Spray Malathion 50 EC 1 ml/lit at weekly intervals.

White fly

Spray Neem Seed Kernal Extract 50 g/lit.

Yield

25 – 30 t/ha in 120 days.

Muskmelon

Cucumis melo L

Cucurbitaceae

Varieties

Annamalai, Pusa Sharbati, Hara Madhu, Durgapura Madhu, Arka Rajhans and Arka Jeet.

Soil and climate

Sandy loam rich in organic matter and with good drainage. The crop requires a moderate warm temperature.

Season and sowing

November to February. Sow the seeds @ 3.0 kg/ha after treating with Thiram or Captan (2 g/kg of seed) on one side of the channel giving a spacing of 0.6 m between hills. Thin the seedlings after 15 days, to maintain two per hill.

Preparation of field

Plough the field to a fine tilth and form long channels at 1.5 m apart.

Irrigation

Irrigate the field before dibbling the seeds and thereafter once in a week.

Application of fertilizers

Apply FYM 20 t/ha, NPK 40:60:30 kg/ha as basal and N @ 40 kg/ha 30 days after sowing.

Aftercultivation

Hoe and weed thrice.

Plant protection

Pests

Beetles and Fruit fly

Spray Malathion 50 EC 1 ml/lit at weekly intervals.

White fly

Spray Neem Seed Kernal Extract 50 g/lit.

Yield

20 t/ha in 120 days.

Tinda

Citrullus vulgaris Schrad *var. fistulousus*

Cucurbitaceae

Varieties

Annamalai and Arka Tinda.

Soil and climate

Sandy loam rich in organic matter and with good drainage. The crop requires a moderate warm temperature.

Season and sowing

Sow the seeds on one side of the channel during January-February.

Seed rate

3.5 Kg/ha.

Treat the seeds with Thiram or Captan 2 g/kg of seed. Thin the seedlings after 15 days to maintain two per pit at 0.9 m spacing.

Preparation of field

Plough the field to fine tilth and form long channels at 1.5m apart.

Irrigation

Irrigate the field before dibbling the seeds and thereafter once in a week.

Application of fertilizers

Apply FYM 10 t/ha, N 20 kg/ha as basal and N 20 kg/ha 30 days after sowing.

Aftercultivation

Hoe and weed thrice.

Plant protection

Beetles and Fruit flies

Spray Malathion 50 EC 1.0 ml/lit.

Yield

10 t/ha in 90 days.

Chow chow

Sechium edule

Varieties

Two types: Green fruited and White fruited.

Soil and Climate

Requires well drained acidic soil with a pH of 5.5 - 6.5 and thrives best in a temperature range of 18 - 22°C and at an altitude of 1200 - 1500 m. In plains it comes up well during winter season.

Preparation of field

Dug pits of 45 cm x 45 cm x 45 cm at a spacing of 2.4 x 1.8 m.

Fill up the pits with 10 kg of FYM, 250 g of urea, 500 g of Super phosphate and 500 g of Muriate of Potash.

Season and sowing

Hills

April - May.

Plains

July - August.

Fully matured and sprouted fruits collected from high yielding vines are planted in pits @ 2 – 3 per pit.

Aftercultivation

Hoeing and weeding are done as and when necessary.

At initiation of vine growth, stake the plants. Provide pandal at a height of 2 m height. Prune the plants to ground level during winter from second year after planting.

In hills, pruning period is January. Apply 250 g of urea for each vine after pruning and at the time of flowering.

Plant protection

Pests

For scales, mealy bugs and aphids spray Dimethoate 30 EC @ 1 ml/lit.

Fruit fly

1) Collect the damaged fruits and destroy.
2) The fly population is low in hot day condition and it is peak in rainy season. Hence adjust the sowing time accordingly.
3) Plough the field to expose the pupae.
4) Use polythene bags fish meal trap with 5 g of wet fish meal + 1 ml. Dichlorvos in cotton. 50 traps are required/ha, fish meal + Dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

Yield

25 - 35 tonnes/ha.

Cluster beans

Cyamopsis tetragonoloba L

Fabaceae

Varieties

Pusa Mausami, Pusa Naubahar and Pusa Sadabahar.

Soil and climate

Well drained sandy loam and warm climate. Tolerates salinity.

Season and sowing

February to July. Dibble the seeds on the sides of the ridges 15 cm apart.

Seed rate

10 kg per ha.

Seed treatment

Treat the seeds with Rhizobial culture at 600 g/ha using rice gruel as binder. Dry the treated seeds in shade for 15 – 30 minutes before sowing.

Preparation of field

Plough the field to fine tilth and form ridges and furrows 45 cm apart.

Irrigation

Irrigate the field immediately after sowing them at weekly intervals.

Application of fertilizers

Apply FYM 25 t/ha, N 25, P 50 and K 25 kg/ha as basal and 25 kg N/ha 30 days after sowing.

Plant protection

Pests

Leaf hopper

Methyl demeton 25 EC 1 ml/lit or Dimethoate 30 EC 1 ml/lit.

Pod borer

Carbaryl 50 WP 2 g/lit; Endosulfan 35 EC 2 ml/lit.

Diseases

Leaf spot

Spray Mancozeb 2 g/lit.

Powdery mildew

Spray Wettable sulphur 2 g/lit or dust with Sulphur 25 kg/ha. Repeat it at 15 days interval.

Yield

5 – 7 t/ha in 90 days.

Vegetable Cowpea

Vigna unguiculata (L) Walp.

Fabaceae

Varieties

Co 2 and Pusa Komal.

Soil and climate

Well drained soil with organic matter. Warm humid climate.

Season

June – July (Rainfed), February – March (irrigated).

Seed rate

20 kg/ha.

Treat the seeds with 600 g of *Rhizobium* bacterial culture before sowing as in cluster beans. Dibble the seeds on both sides of the ridges or in lines in the beds.

Preparation of field

Plough the field to fine tilth. Form ridges and furrows at 45 cm apart or beds of convenient size.

Spacing

45 x 15 cm.

Irrigation

Give irrigation immediately after sowing and on 3rd day, thereafter once a week.

Application of fertilizers

Apply FYM at 25 t/ha and N 25 kg and P 50 kg/ha for irrigated crop. Apply FYM at 12.5 t/ha and N 12.5 kg and P 25 kg/ha for rainfed crop.

Aftercultivation

Give one hoeing and weeding on 25th day after sowing.

Plant protection

Pests

Aphids

Spray Dimethoate 30 EC 1 ml/lit. Methyl demeton 25 EC 1 ml/lit.

Pod Borer

Spray Endosulfan 35 EC 2ml/lit.

Diseases

Powdery mildew

Dust Sulphur 25 kg/ha or spray Wettable sulphur 2 g/lit.

Yield

2500 kg (rainfed) and 5000 kg (irrigated) in a crop duration of 75 to 90 days.

Lab lab or Dolichos bean

Lab lab purpureus var. typicus

Fabaceae

Varieties

Bush types

Co 6, Co 7, Co 8, Co 9, Co 10, Co 11, Co 12, Co 13, Arka Jay and Arka Vijay.

Pandal types

Co 1, Co 2, Co 3, Co 4, Co 5 and Pusa Early Prolific.

Soil and climate

Well drained loamy soil.

Rhizobial treatment

Treat the seeds with three packet (600 g) of Rhizobial culture per ha. using rice gruel as binder. Dry the treated seeds in shade for 15 – 30 minutes before sowing.

Season

Bush type throughout year; Pandal type July – August.

Seed rate and spacing

25 kg/ha for Bush type and 5 kg/ha for Pandal type.

Dibble single seed 30 cm apart on one side of the ridge formed at a spacing of 60 cm for bush type. For pandal type 2 - 3 seeds/pit at 2 x 3 m spacing. Spacing for Co 1 Dolichos beans is 1 x 1 m.

Preparation of field

Plough the land to a fine tilth. Form ridges and furrows 60 cm apart for bush types. Dig pits of 30 cm x 30 cm x 30 cm at required spacing and fill it up with FYM and soil for pandal type.

Irrigation

Immediately after sowing and on 3rd day, thereafter once in a week.

After cultivation

Hoe and weed thrice. Provide stakes to reach pandal of 2 m height and train the vines on pandal.

Application of fertilizers

(a) Basal dressing for bush type

Manures and Fertilizers	Irrigated	Dry
FYM	12.5 t/ha	12.5 t/ha
N	25 kg/ha	12.5 kg/ha
P	50 kg/ha	25 kg/ha
K		

(b) For pandal type

Apply 10 kg FYM per pit (20 t/ha) 100 g of NPK 6:12:12 mixture as basal and 10 g N per pit after 30 days., Apply 2 kg each of *Azospirillum* and *Phosphobacterium* per ha at the time of sowing.

Plant protection

Pests

Sucking pests

Spray Malathion 50 EC 1 ml/lit or Dimethoate 30 EC 1 ml/lit or Methyl demeton 25 EC 1 ml/lit or Fenthion 1 ml/lit at 15 days interval to control aphids and other insects.

Diseases

Powdery mildew

Spray Wettable sulphur 2 g/lit.

Yield

Pandal type : 12 – 13 t/ha in 240 days.

Bush type : 8 – 10 t/ha in 120 days.

French bean

***Phaseolus vulgaris* L**

Fabaceae

Bush type

Varieties

Hills

Watex, Premier, Pusa Parvathi, Arka Komal (Sel.9) and YCD – 1.

Plains

Premier, Arka Komal (Sel.9) and Pusa Parvathi.

Soil and climate

Well drained loamy soils. Cool climate.

Season

Hills

March.

Plains

October.

Sowing

Treat the seeds with *Trichoderma* 4 g/kg or Thiram or Carbandazim @ 2 g/kg of seed 24 hours before sowing to control fungal diseases. If the crop is raised for the first time it should be treated with *Rhizobium* as in cluster beans. In hills, sow the seeds in lines or in beds. In plains, sow the seeds in the sides of the ridges.

Seed rate and spacing

Hills

80 kg/ha (2 seeds/hill) 40 x 10 cm.

Plains

30 kg/ha (2 seeds/hill) 50 x 30 cm.

Preparation of field

Hills

Dig the soil thoroughly and incorporate FYM. Form beds of convenient size.

Plains

After two ploughings form ridges and furrows.

Irrigation

Immediately after sowing, third day and thereafter once a week.

Application of fertilizers

Apply FYM 12.5 t/ha at the last ploughing. N at 90 and P at 125 kg/ha should be applied on one side of the ridges.

For rainfed conditions of Shevaroy hills, apply as a basal dose of 62.5 kg/ha of Phosphorous as super phosphate and with another half of 62.5 kg/ha Phosphorous as FYM enriched super phosphate.

Aftercultivation

Weeding should be given 20 – 25 days and 40 – 45 days after sowing. The crop should be earthed up after each weeding.

Plant protection

Pests

Aphids and Thrips

Treat the seeds with Carbofuran 3 G at 10 g/kg of seed or Monocrotophos 36 WSC 10 ml/kg of seed using adhesive. Spray Monocrotophos 36 WSC or Methyl Demeton 25 EC or Dimethoate 30 EC each at 1 ml/lit. In hills, glass house white fly occurs during May – August. Spray Monocrotophos 36 WSC 1 ml/lit. Place 20 yellow sticky traps coated with castor oil in polythene sheet to attract the white flies.

Pod borer

Spray Carbaryl 50 WP thrice at fortnightly intervals at the rate of 2 g/lit. Dust with Carbaryl 10% at the rate of 2.5 kg/ha or Endosulfan 35 EC @ 2 ml/lit.

Ash weevil

Spray Endosulfan 35 EC @ 2 ml/lit.

Diseases

Powdery mildew

Spray Wettable sulphur at 2 g/lit or dust Sulphur at 25 kg/ha.

Rust

Dust Sulphur at 25 kg/ha.

Anthracnose

Spray Mancozeb at 2 g/lit or Carbendazim 1 g/lit or Chlorothalonil 2 g/lit.

Leaf spot

Spray Mancozeb 2 g/lit.

Root rot

Drench with Carbendazim 1 g/lit.

Yield

8 - 10 t/ha green pods in 90 - 100 days.

Pole types

Varieties

Kentucky Wonder, TKD 1, KKL-I, Murungai bean, Contender and Ooty 1.

Soil

Well drained loamy soils. Requires cool climate.

Season and sowing

Hills

March - May.

Lower elevation of hills

July - October.

Preparation of field

Prepare the land to fine tilth. Sow the seeds at a spacing of 20 cm between plants in double rows of 30 cm apart with the distance of 1.5 metre between each pair of rows.

Seed rate

50 - 55 kg/ha. Treat the seeds with *Rhizobium* (4 packets/ha).

Irrigation

Immediately after sowing, on 3rd day and after once in a week.

Application of fertilizers

FYM 25 t/ha, 90 kg each of NPK as basal and 45 kg each 20 days after sowing.

After cultivation

First weeding and staking 20 days after sowing.

Plant protection

Pests

Leaf hopper

Methyl demeton 25 EC or Dimethoate 30 EC at 2 ml/lit.

Pod borer

Carbaryl 50 WP 2 g/lit.

Diseases

Mosaic

Remove the affected plants and spray with systemic insecticides to control insect vectors.

Powdery mildew

Spray with Wettable sulphur at 2 g/lit or dust with Sulphur 25 kg/ha.

Rust

Dust with Sulphur @ 25 kg/ha.

Anthracnose

Spray with Mancozeb 2 g/lit. Remove the affected plants and pods.

Yield

Green pods 8 - 10 t/ha in 90 to 110 days.

Broad beans

Vicia faba L

Fabaceae

Varieties

Local, SRS 1, BR 1 and BR 2.

Soil and climate

Thrives in almost all soils in hills only. Requires cool climate.

Season and sowing

Sow the seeds during July - August. November - December at 25 kg/ha at 45 x 15 cm spacing.

Preparation of field

Plough the land to a fine tilth and level it and form beds.

Irrigation

Once in 5 days.

Application of fertilizers

Apply 25 t of FYM and 50 kg P and 25 kg K/ha as basal dose. 25 kg N and 25 kg of K/ha are applied between 20 - 25 days after sowing and application of remaining 25 kg of N is done between 40 - 45 days.

After cultivation

Earthing up is done on 45th day after sowing. As soon as the plants start flowering the top is pinched off which causes the pods to develop early.

Yield

400 - 500 kg of Beans/ha in 10 - 12 months.

Peas

Pisum sativum L.

Fabaceae

Varieties

Bonneville, Arkel, Lincoln and Alaska.

Soil and climate

Well drained loamy soil. Thrives best in cool weather. Withstands low temperature at the seedling stage.

Season and sowing

Sow the seeds from February - March and October - November in line. Treat the seeds with *Tricoderma* 4 g/kg or Thiram or Captan at 2 g/kg of seed to avoid seed borne diseases. Treat the seeds with *Rhizobium* culture at the rate of 2 kg and apply 2 kg *Phosphobacterium* as soil application just before sowing.

Preparation of field

Dig the land thoroughly to fine tilth.

Spacing

40 x 10 cm.

Seed rate

100 kg/ha.

Irrigation

Once in a week.

Application of fertilizers

Apply FYM at 20 t/ha and 60 kg N, 80 kg P and 70 kg K/ha as basal and 60 kg N/ha 30 days after sowing.

After cultivation

Weeding should be done 15 days after sowing. Subsequent weedings as and when necessary. Stake the plants.

Plant protection

Diseases

Powdery mildew

Spray Wettable sulphur 2 g/lit or dust Sulphur at 25 kg/ha or Dinocap 1 ml/lit or Tridemorph 0.5 ml/lit, three rounds at 15 days interval.

Yield

8 -12 t/ha in 80 - 110 days.

Annual moringa

Moringa oleifera L.

Moringaceae

Varieties

PKM 1 and KM 1.

Soil

Comes up well in a wide range of soil. A deep sandy loam soil with a pH of 6.5 – 8 is optimum.

Season

July – October.

Seed Rate

Sow one or two seeds per pit at a depth of 2.5 – 3.0 cm.

Preparatory cultivation

Dig pits of size 45 cm x 45 cm x 45 cm with a spacing of 2.5 m either way. Apply 15 kg of compost or FYM/pit after mixing with top soil.

Aftercultivation

Gap filling may be done within a month. Pinch off the seedlings when they are about 75 cm in height to facilitate more branching. Short duration vegetables like Cowpea, Bhendi and Tomato can be grown as intercrop.

Manuring

A fertilizer dose of 45:15:30 g of NPK/pit may be applied 3 months after sowing. Apply 45 g of N/pit after 6 months when the crop is in bearing.

Irrigation

Irrigate before sowing and on the 3rd day after sowing and subsequently at 10 – 15 days interval according to soil type.

Plant protection

Pests

Fruit fly

Spray Dichlorvos 1 ml/lit or Fenthion 1.5 ml/lit to control fruit flies when pods are about 20 – 30 days old. Rake the soil after applying Lindane 1.3 % dust at 25 kg/ha.

Bud worm, Leaf caterpillar and Leaf webber

Dust Carbaryl 10 % at 25 kg/ha.

Ratoon crop

Cut back the trees at 90 cm from ground level after the harvest is over. In another 4 – 5 months, plants will again come for harvest. Ratoon crops can be taken for 3 years. Apply the fertilizer dose of 45:15:30 g NPK/Plant, within a week after cutting back along with 25 kg of FYM or compost every year.

Yield

50 - 55 tonnes of pods/ha (220 pods/tree/year).

Baby corn

Variety

Co 1.

Soil and climate

Suitable for all maize growing soils and climate.

Season

Irrigated	:	Through out the year.
Rainfed	:	June - July and September - October.

Seed rate

25 kg/ha.

Preparation of field

Plough the field to fine tilth. Form ridges and furrows at a spacing of 45 cm x 25 cm.

Irrigation

First irrigation after sowing, thereafter once in ten days.

Application of fertilisers

Apply FYM 12.5 t/ha, NPK 75, 60, 20 kg/ha as basal, 75 kg N and 20 kg K top dressed on 25th day after sowing.

Aftercultivation

First weeding	:	15 days after sowing.
Earthing up and top dressing	:	25 days after sowing.
De-Tasseling (removal of male flowers before pollen shedding)	:	40 - 45 days

Plant protection

Basal application

Carbofuran 3 G 10 kg/ha is to be applied and incorporated.

Yield

1.	Tender cob (baby corn)	:	6660 kg/ha
2.	Green fodder	:	32.2 t/ha

Chapter B

Cole vegetables

Cabbage

Brassica oleracea var. capitata

Brassicaceae

Varieties

Hills

September Eclipse, Pusa Drum Head, Early Wonder, Pride of India and Questo.

Plains

Golden Acre, Large Solid, Late Drum Head, Early Autumn Giant and Maha Rani.

Soil and climate

It is commonly cultivated in cool moist climate. It is grown as a winter crop in plains. It is grown in varied types of soils ranging from sandy loam to clay. It requires a pH ranging from 5.5 to 6.5 for higher production.

Season and sowing

Hills

January – February, July – August, September – October.

Plains

August – November.

Seed rate

375 g/ha.

Nursery

100 sq.m nursery area/ha. Apply FYM at 300 kg, and 10 kg of No.5 mixture (9:9:9) along with 50 g of Sodium molybdate and 100 g of Borax. Sow the seeds at 10 cm between rows in raised seed beds after drenching it with Copper oxychloride (2.5 g/lit). Transplant 30 – 40 days old seedlings at a spacing of 45 cm. Avoid land infected with 'club root disease'.

Preparation of field

Bring the soil to a fine tilth. Pits should be taken up at a spacing of 40 cm either way in Hills. Ridges and furrows are formed at 60 cm apart in plains.

Irrigation

Provide continuous supply of moisture.

Application of fertilizers

Hills

Apply 30 t/ha FYM, 90 kg N, 90 kg P and 90 kg K as basal and 45:45:45 kg NPK/ha 30 to 45 days after planting. Departmental Micronutrient mixture (Borax & Molybdenum) at the rate of 2 kg per ha as basal dressing.

Plains

Apply 20 t/ha of FYM. 50 kg N, 125 kg P and 25 kg K/ha along with 2 kg *Azospirillum* as basal and 50 kg N after one month of planting and earth up.

Aftercultivation

Deep hoeing should be avoided, as the Cabbage roots are surface feeders.

Plant protection

Pests

Cut worms

Apply Chlorpyriphos 2 ml/lit in the collar region during evening hours for the control of common cutworm - *Agrotis segetum.*

Aphids

The incidence is severe during autumn season. Install yellow sticky trap at 12 no/ha to monitor "macropterous" adults (winged adult).

Spray Neem oil 2 % or Dimethoate 2 ml/lit with 0.5 ml Teepol/lit.

Diamond backmoth

1. Grow mustard as intercrop at 20:1 ratio to attract Diamond back moths for oviposition. Periodically spray the mustard crop with insecticide to avoid the dispersal of the larvae.
2. Install pheromone traps at 12 no/ha.
3. Spray Cartap hydrochloride 1 g/lit or *Bacillus thuringiensis* 2 g/lit at primordial stage (ETL 2 larvae/plant)
4. Spray NSKE 50 g/lit after primordial stage.
5. Release parasite *Diadegma semiclausum* at 50,000/ha, 60 days after planting.

Diseases

Club root

Dip the seedlings in Carbendazim solution (1 – 2 g/lit) for 2 minutes. Drench the soil around the seedlings in the main field with Carbendazim @ 1 g/lit of water. Follow crop rotation. Crucifers should be avoided for three years.

Leaf spots

Spray Mancozeb at 2 g/lit or Carbendazim 1 g/lit.

Ring spot

Spray Mancozeb 2 g/lit or Carbendzim 1 g/lit or Copper oxychloride 2.5 g/lit.

Downy mildew

Spray combination of (Metalaxyl + Mancozeb) 2 g/lit 3 sprays at 10 days interval.

Black rot

Dip the seeds in 100 ppm Streptocycline for 30 minutes. Two sprays with 2 g/lit Copper oxychloride + Streptomycin 100 ppm after planting and head formation.

Yield

Hills : 50 – 60 t/ha in 150 days.

Plains : 25 – 35 t/ha in 120 days.

Cauliflower

Brassica oleracea var. botrytis

Brassicaceae

Varieties

Hills

Kibo Giant, Snow Ball, Second Early, Early Kunwari, Second Early Kunwar and Pusa Dapoli.

Plains

Marvel, Patna Midseason, Second Early, Early Synthetic and Pusa Dapoli.

Soil and climate

It requires cool moist climate. The early varieties may tolerate higher temperature and long

days. This can be grown in plains during September to February. Deep loamy soils are good with higher organic matter and good drainage. It can be grown in a pH range of 5.5 to 6.6.

Season and sowing

Nursery

100 sq.m nursery area/ha. Apply FYM at 300 kg and 10 kg of No.5 mixture (9:9:9) along with 50 g of Sodium molybdate and 100 g of Borax. Sow the seeds at 10 cm between rows in raised seed beds after drenching it with Copper oxychloride (2.5 g/lit). Transplant 30 to 40 days old seedlings at a spacing of 45 cm. Avoid land infected with 'club root disease'.

Seed rate

375 g/ha.

Sow the seeds in raised beds and transplant 25 days (early varieties), 45 days old seedlings (late varieties) at 45 cm apart.

Preparation of field

Bring the soil to fine tilth. Pits should be taken at a spacing of 45 cm either way in hills. Form ridges and furrows at 60 cm in plains.

Irrigation

Hills

Once in a week during January and February.

Plains

Once in a week.

Application of fertilizers

Hills

Apply 30 t/ha of FYM and 90 kg N, 90 kg P and 90 kg K as basal dose and 45:45:45 kg NPK/ha after 45 days.

Plains

Apply 15 t of FYM/ha and 50 kg N, 100 kg P and 50 kg K as basal and 50 kg N after 45 days. Apply 2 kg of Departmental Vegetable micronutrient mixture without mixing with the chemical fertilizers.

Aftercultivation

Gap filling after 20 days of planting to maintain the population and uniform growth. Hoeing and weeding on 30th and 45th day. Avoid deep intercultivation as it is a shallow rooted crop.

Plant protection

Pests

Cut Worms

Set up light trap in summer months. Spray Chlorpyriphos 2 ml/lit in the collar region during evening hours.

Aphids

The incidence is severe during autumn season. Install yellow sticky trap at 12 no/ha to monitor Macropterous adults (winged adult).

Spray Neem oil 3 % or Dimethoate 2 ml/lit with 0.5 ml Teepol/lit.

Diamond backmoth

Grow mustard as intercrop at 20:1 ratio.

Install pheromone traps at 12 No/ha.

Spray Cartap hydrochloride 1 g/lit or *Bacillus thuringiensis* 1g/lit or Chlorpyriphos 2ml/lit. at primordial stage (ETL 2 larvae/plant)

Spray NSKE 50 g/lit after primordial stage.

Release larval parasite *Diadegma semiclasum* (Ichneumonidae: Hymenoptera) at 50,000/ ha, 60 days after planting.

Diseases

Club root

Dip the seedlings in Carbendazim solution (1 – 2 g/lit) for two minutes. Drench the soil around the seedlings in the main field with Carbendazim @ 1 g/lit. Follow crop rotation. Crucifers should be avoided for three years.

Leaf Spot

Spray Mancozeb at 2 g/lit or Carbendazim 1 g/lit.

Blanching

Blanching refers to covering of curds. A perfect curd of flower is pure white. It is necessary to exclude sunlight to obtain this. The common practice is to bring the outer leaves up over the curd and tie them with a twine or rubber band. By using a different coloured twine each day. It is easy at the time of harvest to select those tied earlier.

Physiological disorders

Browning or brown rot

This is caused by Boron deficiency. It appears as water soaked areas and later changes into rusty brown. Spray one kg of Borax in 500 lit of water 30 days after planting.

Whip tail

This results from the deficiency of Molybdenum. It is more pronounced in acidic soil. The leaf blades do not develop properly. In severe cases only the midrib develops and it can be corrected by spraying 100 g of Sodium molybdate in 500 lit of water 30 days after planting.

Buttoning

The term buttoning is applied to the development of small curds or buttons. The plants do not develop normally and leaves remain small and do not cover the developing curds. Deficiency of Nitrogen and planting the early varieties late may cause these symptoms. Avoid transplanting aged seedlings.

Blindness

Blind-cauliflower plants are those without terminal buds. The leaves are large, thick, leathery and dark green. It is due to the prevalence of low temperature when the plants are young or due to damage to the terminal bud during handling the plants or due to injury by pests.

Yield

20 – 30 t/ha in late varieties.

15 – 20 t/ha for early varieties.

Chapter C

Root and Tuber vegetables

Carrot

Daucus carota L

Umbelliferae

Varieties

Hills

Ooty-1 and Early Nantes.

Plains

India Gold, Pusa Kesar and Half Long Danvers.

Soil and climate

The Carrot is a cool season crop and when grown at 15°C to 20°C will develop a good colour. The carrot crop needs deep loose loamy soil.

Season and sowing

Hills

At elevation above 1500 metres, Carrot can be grown throughout the year under assured irrigation. At elevations between 1000 – 1500 metres. Carrot can be grown in July – February.

Plains

August.

Seed rate

4 kg/ha.

Mark the rows with a spacing of 25 – 30 cm apart. Sow the seeds mixed with sand (one part of seed with 4 parts of sand).

Thinning

Hills

10 cm between plants.

Plains

5 cm between plants.

Preparation of field

Hills

Prepare the land to a fine tilth and form raised beds of one metre breadth and convenient length.

Plains

Two ploughings are given and ridges and furrows are formed at 30 cm spacing.

Irrigation

Once in five days.

Application of fertilizers

30 t FYM and 90:90:90 kg of NPK per ha as basal dose and 45:45:45 kg NPK after 45 days. Apply 25 kg of $ZnSO_4$/ha as basal.

Aftercultivation

Spray Fluchloralin 1 lit a.i./ha immediately after sowing the seeds to control weeds or first weeding to be done on 15th day. Thinning and earthing up should be given on 30th day.

Plant protection

Carrot is not much affected by pests.

Diseases

Leaf spot

Spray Mancozeb at 2 g/lit.

Yield

25 – 30 t/ha in 100 – 120 days.

Radish

Raphanus sativus L

Brassicaceae

Varieties

Hills

Nilgiris Red, White Icicle, Japanese Long.

Plains

Co 1, Pusa Rashmi, Pusa Chetki, Pusa Desi, Japanese White and Arka Nishant.

Soil and climate

Sandy loam soils with high organic matter. Roots of best size, flavour and texture are developed at about 15°C.

Season and sowing

March in hills and from September in plains.

Seed rate

10 kg/ha.

Preparation of field

The land should be prepared to fine tilth and levelled.

Spacing

30 x 10 cm.

Irrigation

Plains

Once in a week.

Application of fertilizers

Plains

Apply FYM at 25 t/ha and 25 kg N, 100 kg P and 50 kg K/ha as basal dressing and 25 kg N/ha after 30 days.

Aftercultivation

Weeding and hoeing. At the second weeding, thinning of thickly sown plants should be done.

Plant protection

Pests

Aphids, flea beetles and mustard saw fly

Spray Malathion 50 EC 1 ml/lit twice or thrice at 10 days interval.

Diseases

White rust

Spray Mancozeb 2 g/lit or Copper oxychloride 2 g/lit.

Yield

20 – 30 t/ha in 45 – 60 days.

Beet root

Beta vulgaris L.

Chenopodiaceae

Varieties

Ooty 1, Crimson Globe, Detroit Dark Red and Red Ball.

Soil and climate

It comes up well in all types of friable soils. It is considered to be a cool weather crop.

Season and sowing

July – August.

Seed rate

Sow 6 kg/ha directly in ridges at a spacing of 10 cm.

Preparation of field

Plough to a fine tilth and ridges and furrows are formed at 30 cm apart.

Irrigation

Irrigate the field copiously immediately after sowing and afterwards as and when necessary.

Application of fertilizers

Apply FYM at 20 t/ha and 60:160:100 kg NPK/ha as basal and 60 kg N/ha after 30 days.

Aftercultivation

20 days after sowing thin to a single seedling per hill.

Plant protection

Pests

Leaf miner and flea beetle

Spray Malathion 50 EC 2 ml/lit.

Diseases

Cercospora leaf spot

Spray Mancozeb at 2 g/lit.

Rhizoctonia root rot

Spot drenching with Carbendazim at 1 g/lit.

Yield

20 - 25 t/ha in 120 days.

Potato

Solanum tuberosum L.

Solanaceae

Varieties

Kufri Jyoti, Kufri Muthu, Kufri Swarna, Kufri Thangam, Kufri Malar and Kufri Ashoka.

Soil and climate

The soil should be friable, porous and well drained. The optimum pH range is 4.8 to 5.4. It is a cool weather crop. Potato is mostly grown as a rainfed crop. Cultivated in regions receiving a rainfall of 1200 – 2000 mm per annum.

Season and planting

Hills

Summer	:	March – April
Autumn	:	August – September
Irrigated	:	January – February

Plains

October – November.

Use disease free, well spouted seeds weighing 40 – 50 grams. Use Carbon disulphide 30 g/ 100 kg of seeds for breaking the dormancy and inducing sprouting of seeds. Plant the tubers at 20 cm apart.

Seed rate

3000 – 3500 kg/ha.

Preparation of field

Prepare the land to fine tilth. In hills provide an inward slope of 1.40 in the terraces. Provide drainage channel along the inner edge of the terrace. Form ridges and furrows with a spacing of 45 cm between ridges either by hand hoe or ridger.

Irrigation

Irrigate the crop 10 days after planting. Subsequently irrigation should be given once in a week.

Application of fertilizers

Apply 15 t of FYM/ha, and 2 kg each of *Azospirillum* and *Phosphobacterium* as basal and 120 kg N, 240 kg P and 120 kg K/ha in two splits; half as basal and the balance for top dressing 30 days after sowing. Apply Magnesium sulphate at 60 kg/ha as basal dose.

Aftercultivation

Weed control

Spray of Gramaxone @ 2.5 lit/ha in 500 lit of water as post – emergence. The critical period of weed-competition is upto 60 days and it is essential to keep the field weed-free during that period. Take up the first hoeing on 45th day without disturbing stolons. Second hoeing and earthing up at 60th day.

Plant protection

Pests

Nematodes

Avoid growing potato year after year in the same field. Follow rotation of crop with vegetables and green manure. Application of Carbofuran 3 G (1.0 kg a.i.) 33 kg/ha in furrows while seeding. For cyst nematode resistant variety Kufri Swarna, half dose of the above nematicide is enough.

Biological control of Potato cyst nematodes

Applicaton of *Pseudomonas fluorescens* at 10 kg/ha at the time of planting.

Aphids

Spray Methyl demeton 25 EC or Dimethoate 30 EC 2 ml/lit.

Cut worms

1. Install light trap during summer to attract adult moths.
2. Install Sprinkler irrigation system and irrigate the field in day time to expose the larvae for predation by birds.
3. Drench the collar region of the plants in evening hours with Chlorpyriphos or Endosulfan 2 ml/lit a day after planting.

White grub

1. Summer ploughing to expose the pupae and adults.
2. Dust Endosulfan 5 % or Quinalphos 5 % D at 25 kg/ha 10 days after first summer rains.
3. Install light traps between 7 p.m. and 9 p.m. in April - May months.
4. Presowing soil application of entomogenus fungus *Metarrhizium anisopliae* 1x10 FIB/g during the month of May at the rate of 20 kg/ha and fork the soil.
5. Hand pick the adult beetles in the morning.

6. Hand pick the 3rd instar grub during July - August.
6. In endemic areas apply Phorate 10 G at 25 kg/ha during autumn season (August - October).

Potato Tuber moth

1. Avoid shallow planting of Tubers. Plant the tubers to a depth of 10 - 15 cm deep.
2. Install pheromone traps at 20 No/ha.
3. Earth up at 60 days after planting to avoid potato tuber moth egg laying in the exposed tubers.
4. To control foliar damage spray NSKE 50 g/lit or Quinalphos 20 EC 2 ml/lit (ETL 5 % leaf damage).
5. Keep pheromone traps in godowns.
6. In godowns cover the upper surface of potato leaves with *Lantana* or *Eupatorium* branches to repel ovipositing moths.
7. Treat the seed tubers with Quinalphos/Endosulfan dust @ 1 kg/100 kg of tubers.

Diseases

Late blight

Carefully select seed tubers. Remove ground creepers which serve as a source of infection. Spray Mancozeb 2 g/lit or Chlorothalonil 2 g/lit on 45, 60 and 75 days after planting. Grow late blight resistant varieties like Kufri Jyothi, Kufri Malar and Kufri Thangam.

Brown rot

Select disease free seeds. Give proper drainage facilities. Remove and destroy the affected plants.

Early blight

Spray Mancozeb 2 g/lit or Chlorothalonil 2 g/lit at 45, 60 and 75 days after planting.

Virus diseases

Use virus free potato seeds. Rogue the virus affected plants regularly. Control the aphid vectors by spraying Dimethoate or Methyl demeton 2 ml/l.

Yield

15 – 20 t/ha in a duration of 120 days.

Sweet potato

Ipomoea batatas (L) Lam

Convolvulaceae

Varieties

Co 1, Co 2, Co 3 and Co-CIP. 1.

Soil and climate

Can be grown in loamy soil. It requires a warm and moist climate.

Season and planting

June – July and September - October. Plant the terminal vine cuttings (80,000/ha) at 20 cm spacing. Dip the vine cuttings in a solution by mixing 400 g of *Azospirillum* in sufficient quantity of water.

Preparation of field

Plough the field to fine tilth. The soil depth should be atleast 30 cm. Form ridges and furrows at 60 cm apart. Can be grown in beds also.

Irrigation

Irrigate before planting, on 3rd day and then once in a week.

Application of fertilizers

Apply 25 t FYM/ha and 20:40:60 kg NPK/ha as basal and 20:40:60 kg NPK/ha after 30 days. If 20 kg/ha *Azospirillum* is applied, apply only $2/3^{rd}$ dose of N.

Aftercultivation

The field should be kept clean by hand weeding till vines are fully developed. The vines are lifted and turned on the 60th day to prevent root formation at nodes and to make the originally formed roots larger. Spray Ethrel five times at 250 ppm at fortnightly intervals commencing from 15 days after planting for better tuber formation.

Plant protection

Pests

Sweet potato weevil

1. Remove previous sweet potato crop residues and alternate host i.e., *Ipomoea* sp. and destroy them.
2. Use pest free planting materials.
3. Dip the planting material in Fenthion 80 EC or Fenitrothion 25 EC or Monocrotophos 35 WSC @ 2 ml/lit.

4. Rake up the soil and earth up at 50 days after planting.
5. Drench the soil with Endosulfan 35 EC or Fenthion 100 EC at 2 ml/lit. Spray any one of the insecticides, if needed.
6. Harvest the crop immediately after maturity and destroy the crop residues.
7. Install yellow sticky trap at 12 no/ha.

Diseases

Soft rot

Spot drench with Carbendazim 1 g/lit.

Yield

25 – 30 t/ha of tubers in 110 – 120 days.

Tapioca

Manihot esculenta Crantz.

Euphorbiaceae

Varieties

Co 1, Co 2, Co 3, MVD 1, H 165, H 226, Sree Vishakam (H.1687), Sree Sahaya (H.2304), Sree Prakash (S. 856), Sree Vijaya and Sree Jaya.

Soil and climate

Any well drained soil preferably red lateritic loam. Thrives best in tropical, warm humid climate with well distributed rainfall of over 100 cm per annum. Cultivated upto an elevation of 1000 m.

Season and planting

Plant throughout the year under irrigation. Plant during October for rainfed crop. Select healthy mosaic free vigorous plants for taking planting materials. Prepare setts of 15 cm long with 8 – 10 nodes from the middle portion of the stem. Avoid mechanical damage while preparation and handling of setts. The cut end should be uniform. Dip the setts in Carbendazim 1 g in 1 lit of water for 15 minutes before planting. Plant the setts vertically with buds pointing upward on the sides of ridges and furrows. 17,000 setts are needed for one ha.

For rainfed conditions, treat the setts with Potassium chloride @ 5 g/lit for 20 minutes.

Dip the setts for 20 minutes in *Azospirillum* 30 g/lit. before planting.

Preparation of field

Plough the field 4 – 5 times to get a fine tilth. The soil depth should be atleast 30 cm. Form ridges and furrows at the following spacings:

Irrigated

75 x 75 cm (17,777 setts)

Rainfed

60 x 60 cm (27,777 setts)

Under Kanyakumari conditions

90 x 90 cm (12,345 setts)

Irrigation

First irrigation is given at the time of planting. Life irrigation is given on the 3rd day followed by once in 7 – 10 days upto 3rd month and once in 20 – 30 days upto 8th month.

Manuring

Irrigated crops

Apply 25 t FYM/ha and incorporate at the time of planting. Apply 30:60:75 kg NPK/ha as basal and 30:75 kg NK/ha 90 days during earthing up.

Rainfed crop

FYM at 12.5 t/ha along with 50 kg N, 65 kg P and 125 kg K/ha as basal. 2 kg of *Azospirillum* as soil application at 30 – 60 days after planting on receipt of showers (2.0 kg *Azospirillum* + 20 kg FYM + 20 kg soil per hectare).

Aftercultivation

Fill up the gaps within 20 days of planting. Carry out 1st weeding 20 days after planting. Subsequent weedings should be done once in a month upto 5 months depending upon the weed intensity.

Thin to two shoots per plant during 60th day. Grow aggregatum onion, coriander, short duration pulses and short duration vegetables as intercrops.

Plant protection

Pests

Mites

Soaking spray with Dicofol 18 EC 2.5 ml/lit during 3rd and 5th month.

White fly

Integrated pest management practices:

1. Remove alternate weed hosts viz., *Abutilon indicum.*
2. Install yellow sticky trap at 12 no/ha.
3. Use nitrogen judiciously.
4. Avoid excessive irrigation.
5. Spray Neem oil 5 ml/l or fish oil resin soap 20 g/lit or Methyl demeton 35 EC 2 ml/l. While using Neem oil teepol or sandovit should be added at 1 ml/l for better contact with foliage. Apply Methyl demeton in the early stage and Phosalone in the late stages of crop growth.
6. Avoid use of synthetic pyrethroids.
7. Avoid extending the crop growth beyond its duration.

Diseases

Mosaic

Select the planting materials from healthy plants. For the control of white fly vectors, adopt IPM practices mentioned above.

Cercospora Leaf spot

Spray Mancozeb at 2 g/lit twice at 15 days interval.

Tuber rot

Avoid water stagnation. Give good drainage facilities. Spot drenching with Copper oxychloride 2.5 g/lit.

Iron deficiency

Spray 3 to 4 times Ferrous sulphate 2.5 g/lit on the appearance of deficiency symptom at weekly intervals. Equal quantity of lime should be added for neutralising the solution.

Crop duration

9 to 11 months.

Yield

Irrigated	:	40 - 50 t/ha
Rainfed	:	20 - 25 t/ha

Elephant Foot yam

Amorphophallus companulatus Blume

Araceae

Varieties

Local.

Soil and climate

Rich red-loamy soil is preferred. It is a tropical and subtropical crop. It requires well distributed rainfall with humid and warm weather during vegetative phase with cool and dry weather during the corm development period.

Season and planting

April – May.

The tuber is cut into small bits in such a way that each bit has atleast a small portion of the ring around each bud. There are also projections with tender buds called "Arumbu". These are removed before planting as they do not give vigorous growth. An ordinary sized yam gives about 6 to 8 bits for planting. The cut pieces are dipped in cow dung solution to prevent evaporation of moisture from cut surface. In some places, the small round daughter corms are also planted. The cut pieces are planted in beds at 45 cm x 90 cm spacing. The pieces are planted in such a way that the sprouting region (the ring) is kept above the soil. About 3500 kg of corms will be required to plant one hectare. Sprouting takes place in about a month.

Preparation of field

The land is brought to fine tilth and form beds of convenient size.

Irrigation

Weekly once.

Application of fertilizers

Apply 25 tonnes of FYM/ha and incorporate during last ploughing and 80:60:100 kg NPK/ha two months later.

Aftercultivation

Weeding and earthing up as and when necessary.

Yield

30 – 35 t/ha in 240 days.

For seed purpose, the yams can be left in the field itself till planting the next crop or the lifted yams can be stored in sand or paddy straw.

Colocasia

Colocasia esculenta L. Scott

Araceae

Varieties

Co 1, Panchamukhi and Kovvur.

Soil and climate

It comes up well in loamy soils and a combination of warm and moist climate. It can be grown up to 1500 m elevation.

Seed rate

800 kg/ha.

Season and planting

June – July and February – March. Plant at a spacing of 45 cm in furrows.

Preparation of field

Plough the field to a fine tilth and form ridges and furrows at a spacing of 45 cm.

Irrigation

Once in a week.

Application of fertilizers

Apply 25 tonnes of FYM, 20 kg N, 30 kg P and 60 kg K/ha as basal and 20 kg N, 30 kg P and 60 kg K/ha 45 days after planting.

Aftercultivation

Weeding and earthing up should done 45 to 60 days after planting. Deep cultivation should be avoided. It requires profuse irrigation and shade.

Yield

8 – 10 t/ha in 180 days.

Dioscorea

Dioscorea esculenta L. *Dioscorea alata* L.

Dioscoreaceae

Varieties

Peruvalli (*D.alata*) : Co 1

Siruvalli (*D.esculenta*) : Local

Soil and climate

Sandy loam with good drainage and cool weather.

Season and planting

May – June.

Use mature tubers or pieces of tubers taken from the previous crop as seed material at the rate of 1875 – 2500 kg/ha. Mini setts of 25 g is recommended for planting directly in the field or raising a nursery and planting plants after 60 days. Planting is done in beds or in ridges or in mounds or in rows 75 cm apart either way.

Preparation of field

Plough the field to a fine tilth and form ridges and furrows at 75 cm spacing.

Irrigation

Copious watering once in a week is necessary.

Application of fertilizers

Apply FYM @ 25 t/ha at the time of last ploughing. Follow fertilizer schedule of 40:60:120 kg NPK/ha as basal. 4 kg/ha of *Azospirillum* (mixed with 40 kg of soil) 30 days after planting. Apply 50 kg N and 120 kg K/ha 90 days after planting.

Aftercultivation

The vines should be trained on bamboo poles. Weeding as and when necessary.

Yield

20 – 25 t/ha in 240 days.

Coleus

Coleus parviflorus L.

Syn. *Solenostemon rotundifolius*

Labiatae

Varieties

Co 1.

Soil and climate

Red, loamy and well drained soils. Comes up well in shade with warm humid climate.

Season and planting

Harvest the tubers in January and store under room temperature for two months. Plant the sprouted tubers in the nursery beds in March – April. Use herbaceous cuttings of 10 cm length taken from the nursery beds and plant in the main field during July – August at a spacing of 30 cm.

Preparation of main field

The field is ploughed 4 to 5 times to a fine tilth and form ridges and furrows 60 cm apart.

Irrigation

At weekly intervals.

Application of fertilizers

FYM at 25 t/ha as basal and NPK at 30:60:150 kg/ha. Apply 30 kg N 30 days after planting at the time of earthing up along with 2 kg of *Azospirillum*.

Aftercultivation

2 or 3 weedings and earthing up 2 months after planting.

Yield

15 to 20 t/ha in 120 days.

Chapter D

Bulb vegetables

எழும்பூர். சென்னை-600 008

Onion - Small Onion (Aggregatum)

Allium cepa var. aggregatum

Alliaceae

Varieties

Co 1, Co 2, Co 3, Co 4 and MDU 1.

Soil and climate

Red loam to black soils with good drainage facilities and mild season without extremes of heat and cold.

Season and sowing

Sow the medium sized bulbs during April – May and October – November.

Seed rate

1000 kg/ha.

Preparation of field

Plough the land to a fine tilth. Form ridges and furrows at 45 cm spacing. Sow the bulbs on both the sides of the ridges at 10 cm apart.

Irrigation

After sprouting, irrigate at weekly intervals. Withhold irrigation 10 days before harvest.

Application of fertilizers

Apply FYM 25 t/ha. N 30 kg, P 60 kg and K 30 kg/ha as basal and 30 kg N/ha on 30th day of sowing.

Plant protection

Pests

Thrips and onion fly

Methyl demeton 25 EC 1 ml/lit or Dimethoate 30 EC 1 ml/lit or Monocrotophos 30 WSC 1 ml/lit with Teepol 0.5 ml/lit.

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Cutworm

Drench the soil with Chlorpyriphos @ 2 ml/lit.

Diseases

Leaf spot

Spray Mancozeb 2 g/lit or Copper oxychloride 2.5 g/lit. Add Teepol 0.5 ml/lit of spray fluid.

Harvest and Yield

12 – 16 t/ha in 70 to 90 days.

Clean and dry the bulbs for 4 days in shade soon after harvest.

Spray Maleic hydrazide at 2500 ppm 15 days before harvest to extend the shelf life of onion.

Bellary onion

Allium cepa var. cepa

Alliaceae

Varieties

Bellary Red, Pusa Red, NP 53, Arka Niketan, Arka Kalyan, Agri Found Light Red and Agri Found Dark Red.

Soil and climate

Red loam to black soils with good drainage facilities. Mild season is preferred.

Season

May – June.

Seed rate and Sowing 10 kg/ha. Treat the seeds with *Azospirillum* @ 400 g/kg of seed using rice gruel as adhesive, dry under shade for 30 minutes and sow them. Apply VAM in the beds along with FYM before sowing.

Preparation of main field

Plough the land to get a fine tilth and incorporate 25 t/ha of FYM at the time of last ploughing. Form ridges and furrows at 45 cm spacing. Plant 45 days old seedlings at 10 cm apart on both the sides of the ridges.

Irrigation

After establishment irrigate at weekly intervals.

Application of fertilizers

Apply N 50 kg, P 150 kg and K 75 kg/ha as basal dose and N 50 kg/ha as top-dress 30 days after planting. Apply Zinc sulphate as basal dose @ 50 kg/ha at the time of last ploughing.

Plant protection

Pests

Thrips and onion fly

Methyl demeton 25 EC 1 ml/lit or Dimethoate 30 EC 1 ml/lit or Monocrotophos 30 WSC 1 ml/lit with Teepol 0.5 ml/lit.

Cutworm

Drench the soil with Chlorpyriphos @ 2 ml/lit.

Nematode

Application of Carbofuran 3 G 1 kg a.i./ha or Phorate 10 G 1 kg a.i./ha at 10 days after transplanting.

Disease

Leaf spot

Spray Mancozeb 2 g/lit or Copper oxychloride 2 g/lit. Add 1 ml of Teepol to 1 lit spray fluid.

Yield

15 – 18 t/ha in 140 – 150 days.

Chapter E

Leafy vegetables

Amaranth

Amaranthus sp L.

Amaranthaceae

Varieties

Co 1 (Mulaikeerai and Thandukeerai)

Co 2 (Mulaikeerai and Thandukeerai)

Co 3 (Clipping)

Co 4 (Grain)

Co 5 (Mulaikeerai and Thandukeerai)

Soil and climate

Well drained loamy soils and warm climate are suitable.

Season and sowing

Can be sown throughout the year.

Seed rate

2.5 kg/ha.

Broadcast the seeds evenly on the bed after mixing with 10 parts of sand.

Preparation of field

The field is prepared to a fine tilth and beds of 2 x 1.5 m are formed. After germination thin the seedlings to have a spacing of 12 – 15 cm.

Irrigation

Irrigate before and after sowing and at weekly intervals after germination.

Application of fertilizers

Apply FYM 25 t/ha; N 75 kg and K 25 kg per ha as basal dose.

Plant protection

Pests

Ants

Apply Lindane 1.3% dust @ 10 kg/ha around the beds to control ants, termites and other burrowing insects.

Leaf eating caterpillar

Carbaryl 50 WP 2 g/lit.

Harvest and yield

Leafy types

25 days after sowing for Mulaikeerai (10 t/ha);

40 days after sowing for Thandukeerai (16 t/ha).

Clipping types

10 clippings at weekly intervals (30 t/ha).

Grain types

Co 4 – 2.4 t grains/ha + 8 tonnes of tender greens.

CHAPTER F - MINOR VEGETABLE CROPS

Name of crop	Varieties	Method of propogation	Spacing	Manures and Fertilisers	Aftercultivation including special practices	Cropping and harvest	yield
Curry leaf (*Murraya koenigii*)	Green and pink petioled	Seeds	1.5 x 1.5 m	20 kg FYM per tree per year	-	Harvest once in 2 months throughout the year	100 kg leaves per tree per year
Coccinia (*Coccinia indica*)	Padappai	Stem cuttings from pistillate plants	2 x 2 m	10 t FYM, 75 kg N, 40 kg P and 75 kg K/ha	Erection of pandal or trellis and training the vines	Yields 6 months after planting and continues through out the year	10 - 15 t/ha
Chekurmanis (*Sauropus androgynus*)	-	Stem cuttings	45 x 60 cm	5 - 10 kg FYM per plant	Weeding, pruning once in a year	Yields four months after planting throughout the year	5 kg leaves per plant
Bread fruit (*Artocarpus altilis*)	Seedless and seeded types	Root cuttings/air layering of root suckers/seedling	12 x 12 m	-	-	First harvest 5 to 6 years after planting. February - March, June – August	300 - 500 fruits/tree
Ceylon spinach (*Talinum triangulare*)	-	Tender herbaceous stem cuttings	15 x 15 cm	-	Grows well under shade	Harvest within a month after planting and continues throughout the year	4000 - 6000 kg/ha
Mint (*Mentha viridis*)	-	Cuttings	15 x 15 cm	-	-	Harvest one month after planting and continues through out the year	2000 kg/ha
Palak (*Beta vulgaris var. Bengalensis*)	-	Seeds 20 - 25 kg/ha	20 x 10 cm	FYM 25 t/ha, N 60 kg, P 60 kg and K 60 kg/ha	-	First harvest of leaves one month after sowing. Total duration 3 months	20000 kg/ha
Basella (Green : *Basella alba*) (Pink: *Basella rubra*)	-	Stem cuttings and seeds	2 x 2 m in pits	10 kg FYM per pit	Train the vines on trellis or pandals	Harvest 2 months after planting through out the year	4000 - 6000 kg/ha
Brussels sprout (*Brassica oleracea var. Gemmifera*)	Jade cross	Seeds 500 g/ha	60 x 50 cm	-	-	Starts yielding in 6 months; continues for 3 years	4 - 5 t/ha
Asparagus (*Asparagus officinalis var.altilis*)	Marth Washington, Mary Washington.	Seeds and Crowns	30 x 30 cm	Basal: N 50 kg, P 10 kg and K 75 kg/ha	-	Harvest from third year of planting	1250 - 3750 kg/ha
Celery (*Apium graveolens*)	Standard Bearer, Wright Grove Grant Giant Pascal	Seeds (125 g/ha)	60 x 15 cm	Top dress: N 140 kg, P 55 kg and K 220 kg/ha	-	Crop duration 4-5 months	10 t/ha
Rhubarb (*Rheum rhaponticum*)	Victoria, Cherry, Mc Donald, Ruby, Valentino & Sunrise	Root cuttings	Between plants 60 - 120 cm; between rows 1-2 m	Fertiliser mixture of 1:1:1	-	Stalks are harvested 2 years after planting, 5-6 stalks per plant for	-

						further growth. Crop duration 5 years	
Lettuce (*Lactuca sativa*)	Head type, Leaf cos type	Seed (500 g/ha)	30 x 15 cm	Basal and Top: FYM 30 t/ha, N 50/50 kg/ha, P 30/30 kg/ha and K 30/30 kg/ha	Top dressing 60 days after planting	Crop duration 2 months	10-15 t/ha
Knol-khol (*Brassica caulorapa*)	White Vienna, Purple Vienna	Seed (1.5 kg/ha)	30 x 20 cm	Basal and Top: FYM 30 t/ha, N 90 kg/ha, P 125 kg/ha and K 100 kg/ha		Crop duration 75 days in main field	20 - 25 t/ha
Turnip (*Brassica rapa*)	Temperate types: Purple top White Globe Snow Ball Tropical Types: Pusa Chandrima Pusa Sweti Pusa Kanchan	Seed (4 kg/ha)	30 x 15 cm	Basal: FYM 30 t/ha, N 90 kg, P 125 kg and K 100 kg/ha. Top: N 90 kg/ha	Thinning of seedlings	Crop duration 75-90 days	-
Winged Bean (*Psophocarpus tetragonalobus*)	-	Seeds	1 x 0.5 m	Basal: FYM 10 t/ha, N 40 kg, P 100 kg and K 25 kg/ha	Staking	Duration 10-12 months	10-12 t/ha
Chinese cabbage (*Brassica pekinensis*)	Chinese cabbage *Brassica Campestris* Sp. *Pekinensis* Michihili as Veg-I	Seeds (375 g/ha)	45 x 45 cm	Basal: FYM 10 t/ha, N 90 kg, P 125 kg and K 100 kg/ha. Top: 90 kg/ha	Earthing up 60 days after planting	Crop duration 4 months	25 - 35 t/ha
Butter bean *Phaseolus lunatus*	KKL-1	25 to 35 kg/ha	35 x 25 cm	FYM 20-30 t/ha 40:50:50 NPK kg/ha		80-85 days	500 - 1000 kg/ha of grains 5 – 10 t/ha tender pods.

Part III

Spices and Condiments

Chapter A

Spices

Pepper

Piper nigrum L.

Piperaceae

Varieties

Panniyur 1, 2, 3, 4 and 5, Karimunda, Kottanadan, Sreekara, Subhakara, Panchami, Pournami, Ottaplackal 1, Kalluvally, Balamkotta and Uthiramkotta.

In lower elevation and less shady areas Panniyur 1 performs well for higher elevations with more shady area Karimunda is preferable. Panniyur 5 is suited for growing in Arecanut gardens.

Soil and climate

Pepper is grown mainly as a rainfed crop. Pepper requires heavy rainfall (150 - 250 cm) high humidity and warm climate.

Thrives best on virgin soils rich in humus content at elevations up to 1500 m.

Season

June - December.

Planting

Slopes facing West and South should be avoided. Pits of 50 cm x 50 cm x 50 cm size are dug at a spacing of 2 to 3 m in either direction. 5 to 10 kg of FYM/Compost is mixed with top soil and the pits are filled. Rooted cuttings are planted in June - July @ two per standard like Silver oak, Dadap and Jack. In multitier cropping system, standards should be planted at a spacing of 7 – 8 m.

Manuring

Apply cattle manure or Compost @ 10 kg/vine just before the onset of South West monsoon. In addition 100 g of N, 40 g of P and 140 g of K per vine are applied in two split doses in the months of May - June and in September - October. Slaked lime at 500 g per vine is applied in alternate years

during May - June. The manures and fertilizers are applied around the vine at a distance of 30 cm from the base and incorporated into the soil along with 10 g of *Azospirillum* and 25 g $MgSO_4$ 100 g/vine can be applied one month after the application of chemical fertilizers.

Irrigation

Protective irrigation in basins during December - May at 10 days interval is more beneficial wherever facilities are available.

Aftercultivation

Two weedings are given during the months of June - July and at October - November. The vines are to be trained to the standards. Prune excessive foliage of the standards and limit the height of the standards to about 6 m. Spray NAA @ 40 ppm to increase the berry size.

Plant protection

Pests

Pollu Beetle

Spray Endosulfan 35 EC 2 ml/lit once in July and again in October.

Leaf gall thrips

Spray Monocrotophos 36 WSC 1.5 ml/lit or Dimethoate 30 EC 2 ml/lit or Chlorpyriphos 2 ml/lit or Dichlorvos 100 EC 1 ml/lit or Phosphomidan 85 EC @ 1 ml/lit three rounds at monthly intervals starting from new flush formation.

Diseases

Quick wilt

Nursery

Application of *Trichoderma viride* @ 1 g/kg of pot mixture.

Main field

1) Application of neem cakes 1/2 kg per vine.

2) Swabbing Bordeaux paste upto 1 m from the ground level.

3) Application of *Trichoderma viride* @ 20 g/vine along with FYM or Bordeaux mixture 1 % or Metalaxyl-Mancozeb @ 2 g/lit.

Any of the above formulation may be used for drenching the soil twice in a year once during May - June and the other during October - November.

Spray Bordeaux mixture 1% or Fosetyl-Al 3 g/lit or Metalaxyl-Mancozeb 2 g/lit twice in a year once during May - June and the other during October - November. Foliar application of Pseudomonas fluorescens (1% commerical formulation).

Harvest

It starts bearing after 3 years of planting. The harvesting season is from November to March. Harvest is done by hand picking the whole spikes when a few berries in the spike start turning red. The berries are separated and dipped in hot water (80°C) for one minute and sun dried for 7 to 10 days.

Yield

2 to 3 kg/vine/year.

Cardamom

Elettaria cardamomum Maton.

Zingiberaceae

Varieties

Malabar, Mysore, Vazhukka, Mudigree-1, CCS 1, ICRI 1, ICRI 2, PV 1, SRP 14 and Green Gold.

Soil and climate

Thick shady areas with loamy soil are ideal. Grown at an elevation from 600 to 1500 m. Areas exposed to heavy winds are unsuitable. Adequate drainage must be provided.

Season

June - December.

Seeds and sowing

Seedlings/suckers.

Propagation from Seeds

Collect seeds from healthy and good yielding plants. To plant one hectare 600 grams of seeds will be sufficient. Sow fresh seeds. Treatment with commercial grade Sulphuric acid or Hydrochloric acid for 20 minutes. Sowing in the beds, after washing with water will increase the percentage of germination. Prepare the beds to a fine tilth. A mixture of equal quantity of well rotten cattle manure, wood ash and jungle soil is incorporated in the nursery beds.

Provide mulching and shading to seed beds. Sow the seeds on the surface of the bed and just cover the seeds with a thin layer of fine sand. The beds should be kept moist but not too wet. Germination starts usually a month after sowing and goes on for three months. When the seedlings are about one year old, they are transplanted to secondary nursery.

Preparation of the field

Dig pits of 60 cm x 60 cm x 60 cm size and fill with compost and top soil. Contour pla may be done in slopy areas.

Spacing

Larger types	:	2.5 x 2.0 m.
Smaller types	:	2.0 x 1.5 m.

Irrigation

Generally Cardamom is grown as a rainfed crop, but provide sprinkler irrigation during summer for increased yields.

Manuring

Apply compost 25 t/ha; 75 kg N; 75 kg P and 150 kg K/ha in two split doses during June - July and October - November.

Aftercultivation

Shade regulation is important. Weed the field as and when necessary. Towards the end of monsoon rains a light raking or digging and mulching is given around the plant to a radius of about 75 cm to conserve moisture during the dry period.

Plant protection

Pests

Thrips

Spray Monocrotophos 36 EC 2.5 ml/lit.

Hairy caterpillar

Spray Phosalone 35 EC 1 ml/lit.

Shoot and fruit borer

Spray Monocrotophos 36 EC 2.5 ml/lit.

Setup pheromone trap @ 12/ha to attract and destroy the female moths.

Mites

Spray Dicofol 18 EC 2 ml/lit.

Rhizome weevil

Soil drenching of Lindane 20 EC @ 2 ml/litre.

Diseases

Mosaic or Katte disease

This is a serious disease affecting the productivity of Cardamom.

This is transmitted by banana aphid which can be controlled by regular spraying with Methyl demeton 25 EC, Dimethoate 30 EC or Phosphamidon 86 WSC at 750 ml/ha.

Damping off or clump rot or rhizome rot

Drench nursery with 1 lit of Formaldehyde in 50 lit water for 3 sq.m. before sowing. Prophylactic drench with 0.25% Mancozeb or 1% Bordeaux mixture immediately after germination to control *Pythium* and 0.05% Carbendazim after 15 days to control *Rhizoctonia*.

Capsule rot or panicle rot or Azhukal

Three sprays with 1% Bordeaux mixture or 0.25% Copper oxychloride or 0.2% Mancozeb just before onset of South West monsoon in early August and in September. Drench soil with 1% Bordeaux mixture.

Harvest

Harvesting commences from the third year onwards. But good yields are expected from 5th year. Harvesting is generally done once in a month. Pick only those fruits which are just ripe but not fully ripe. Fully ripe fruits tend to split on drying and do not develop the desirable dark green colour.

Yield

100 - 150 kg/ha.

Clove

Syzigium aromaticum

Myrtaceae

Varieties

Local.

Soil and climate

Humid tropical climate with an annual rainfall of 150 - 250 cm and a mean temperature range of 20°C to 30°C and elevation up to 1000 m are suitable. Deep rich loams with high humus content and lateritic soils are the best suited.

Season

June - December.

Slopes facing South and West should be avoided. North and North-Eastern slope is preferred.

Planting

Seeds are extracted from ripe fruits and sown immediately. The seeds germinate in five to six weeks. Two year old seedlings are planted in pits of 30 cm x 30 cm x 30 cm size filled with soil and FYM 10 kg/pit at a spacing of 6 m either way. Apply, 50 g *Azospirillum* before planting.

Aftercultivation

Provide shade for seedlings. Mulch the basins with dried leaves. Weed the basins as and when necessary.

Banana can be grown to provide shade during the initial establishment. Small temporary pandals may provide partial shade during initial establishment.

Irrigation

Frequent watering is essential in the initial stages in the absence of rains. Irrigation should be given during summer months. Applying 8 litres of water either through drip or through basin during the months of January - May is beneficial.

Manuring

One year old plants can be applied with FYM 15 kg, N 20 g, P 20 g, K 60 g in two splits during June - July and September - October. Every year the dosage is correspondingly increased and a bearing tree of 7 years old may be applied with FYM 50 kg, N 300 g, P 300 g and K 960 g. 50 g in each of *Azospirillum* and *Phosphobacterium* to be applied one month after manuring.

Plant protection

Pests

Stem Borer

i. Smear the surface of the stem and branches with Carbaryl 50 WP at 2 g/lit of water.

ii. Pour Quinolphos 25 EC 1 ml/lit in to the bore hole and plug it.

Leaf eating caterpillar

Spray Endosulfan 35 EC 2 ml/lit.

Harvest

Bearing starts from sixth year onwards. The flower buds should be harvested when they are fully mature but before opening. The buds are harvested as clusters and separated and dried in the sun for five to seven days.

Yield

2 - 3 kg dried buds/tree.

Nutmeg

Myristica fragrans Hoult.

Myristicaceae

Varieties

Local.

Soil and climate

Friable, well drained clay to red soils is suitable. Can be grown up to an elevation of 1000 metres with 150-250 cm of rainfall, humid tropical climate.

Season and planting

Seeds or grafts are used as planting material. Seeds germinate in 4 to 6 weeks. Plant 12 - 18 months old seedlings in pits of 60 cm x 60 cm x 60 cm size and filled up with equal parts of forest soil and cattle manure. Spacing of 8 m x 8 m either way. Season of planting is June – December. Nutmeg grafts are better than seedlings. Plant the grafts in the same way as seedlings.

Manuring

Apply FYM 15 kg, N 20 g, P 20 g, K 60 g per tree during first year and FYM 50 kg, N 300 g, P 300 g, K 960 g for adult trees in two splits June - July, September - October. Apply 50 g in each of *Azospirillum* and *Phosphobacterium* one month after manuring.

Irrigation

Irrigation is given once in 5 - 7 days during summer months.

Aftercultivation

Keep the area around the plant weed free. Regulation of shade is important. It requires medium shade especially during the initial stages of growth. Fast growing shade trees or Banana are planted in between them a few months prior to planting and can be thinned out later. It can be grown as mixed crop with Arecanut and Coconut. In Arecanut plantations, Nutmeg can be planted after every third row of Arecanut.

Plant protection

Loranthus sp

It is a serious plant parasite affecting the growth of the nutmeg plant. This can be controlled by mechanical removal of the plant parasite. Remove severely affected branches. Twigs of nutmeg trees may also be removed along with the plant parasite and paint with Bordeaux paste.

Harvest

The bearing starts from six to seven years after planting. The mature fruits when they start splitting are harvested. The aril commonly known ‘mace’ and ‘seed’ are separated and dried.

Yield

Fruits : 1000 - 2000/tree

Dried nuts : 5 - 7 kg/tree

Dried mace : 0.5 - 0.7 kg/tree.

Cinnamon

Cinnamomum zeylanicum Blume.

Lauraceae

Varieties

YCD 1, SL 63.

Soil and climate

Sandy or lateritic soils with high humus are suitable. Requires a sheltered situation can be grown up to an altitude of 800 - 1000 m from MSL receiving an annual rainfall of 150 to 250 cm.

Season

June - December.

Planting

Cinnamon seedlings or rooted cuttings are planted under partial shade. Pits are dug at a distance of 2 m either way filled with top soil and FYM 1.0 kg at 1:1 ratio. One year old seedlings or rooted cuttings are transplanted.

Irrigation

Protective watering during summer in beneficial.

Manuring

Manures and Fertilizers	Ist year	Annual increase	10th year onwards
FYM	-	2 kg	20 kg
N	20 g	20 g	200 g
P	18 g	18 g	180 g
K	25 g	25 g	250 g

Aftercultivation

Immediately after transplanting, the plants are provided with temporary shade by erecting a small pandal. Weeds are removed as and when necessary. Young trees are cut close to the ground to produce side shoots. This process is called "Coppicing". By stooling around the stumps, more side shoots are encouraged from the base of the trees.

Plant protection

Pests

Shoot borer

Smear stem and branches with Carbaryl 50% 2 g/lit of water once in a month.

Coffee red borer

Trunk injection of Monocrotophos 36 WSC 1 ml/bore hole with a waiting period of 20 days to be allowed between application and harvest of the bark.

Leaf eating caterpillar, red ants and termites

Dust Lindane 1.3%.

Diseases

Leaf spot

Spray 1 % Bordeaux mixture.

Harvest

The harvesting starts from 4th or 5th year after planting. The shoots are cut for the extraction of bark once in May and again in November. As soon as rain ceases, cutting of shoots for peeling of bark is commenced. After cutting, young shoots spring up from the stump which will be ready for removal in subsequent season within 18 months. The bark is peeled from the selected shoots of 18 to 24 months old, which are usually one metre long and 1 to 2 cm thick. Shoots ready for peeling are removed from the stumps and terminal ends of shoots are also removed. Peeling is done by knives after scraping off the outer bark. From leaves, Cinnamon oil can be extracted by steam distillation. Harvested produce is called as 'Quills'.

Yield

100 g of dried bark/bush.

35 kg of leaf oil/ha/year.

Chapter B

Condiments

Coriander

Coriandrum sativum L.

Apiaceae

Varieties

Co 1, Co 2 and Co 3

Season

June - July and October - November.

Field preparation and sowing

Prepare the main field to a fine tilth and form beds and channels (for irrigated crop). Sow the split seeds at a spacing of 20 x 15 cm. The seeds will germinate in about 8-15 days.

i) Presowing seed hardening treatment with Potassium Dihydrogen Phosphate @ 10g/lit of water for 16 hours is to be done for rainfed crop.

ii) Seeds are to be treated with *Azospirillum* @ 3 packets/ha.

iii) Seed treatment with *Trichoderma viride* @ 4 g/kg of seed has to be done to control wilt disease.

Seed rate

10 - 12 kg/ha.

Broadcast the seeds for rainfed crop. (20 – 25 kg/ha)

Manuring

Basal

FYM 10 t/ha; 10 kg N, 40 kg P and 20 kg K for rainfed and irrigated crops.

Top dressing

Top dressing may be done at 10 kg N/ha 30 days after sowing for the irrigated crop only.

Irrigation (for irrigated crop only)

First irrigation immediately after sowing and the second on the third day. Subsequent irrigations at 7-10 days interval.

Aftercultivation

Pre-emergence spray of herbicide Fluchloralin 700 ml in 500 lit/ha. Thinning is done 30 days after sowing. Subsequent weeding is done as and when necessary. Leave 2 plants per hill. Spray CCC @ 250 ppm one month after sowing for inducing drought tolerance in rainfed crops.

Plant protection

Aphid

Spray Methyl demeton 20 EC 2 ml/lit or Dimethoate 30 EC 2 ml/lit.

Diseases

Powdery mildew

Spray Wettable sulphur 1 kg/ha or Dinocap 250 ml/ha at the time of initial appearance of the disease.

Grain mould

Spray Carbendazim 0.1 % (500 g/ha) 20 days after grain set.

Harvest

The plants are pulled just when the fruits are fully ripe but green and start drying. The plants are dried and thrashed with sticks, winnowed and cleaned. For leaf, pull out the plants when they are 30-40 days old.

Yield

Rainfed Grain yield	:	300-400 kg/ha.
Irrigated	:	500-600 kg/ha
Leaf yield	:	6-7 t/ha.

Garlic

Allium sativum L.

Alliaceae

Varieties

Local, Ooty 1, Farwi, Rajalle Gaddi and Singapore.

Season

June-July; Oct-Nov.

Soil and climate

Well drained, silt or clay loam soils are suitable. Require relatively cool weather.

Seeds and sowing

The field is prepared to a fine tilth. Shallow furrows are formed at a spacing of 15 cm. The seed bulbs called as 'cloves' at a seed rate of 500-600 kg/ha are planted at a spacing of 10 cm.

Manuring

Basal

FYM 50 t/ha; 40 kg N, 75 kg P and 75 kg K/ha + Neem cake 1 t/ha + 50 kg of $MgSO_4$/ha.

Top dressing

35 kg N/ha at 45 days after planting.

Controlling rubberisation

Avoid excessive application of N to minimise rubberisation. N should not be applied in the form of Urea. Use Ammonium sulphate. Spray 1500 ppm of CCC or MH on 30th day of planting. Reduce the frequency of irrigation to minimise rubberisation. Apply 0.2 % Boron 0.1 % Sodium molybdate on 30th, 60th and 90th days after planting.

Aftercultivation

3-4 hand weeding and earthing up.

Plant protection

Pests

Thrips

Spray Methyl demeton 25 EC or Dimethoate 30 EC 2 ml/litre. Acephate 75 SP 1 g/lit or Phosphomidan 85 EC 1 ml/litre.

Focus the spray fluid in the leaf whorls.

Diseases

Bulb rot

Clove treatment with Carbendazim at 2 g/kg and spot drench with Carbendazim 1 g/lit of water.

Leaf blight

Spray Carbendazim 500 g/ha.

Nematode

Soaking seed cloves in water over night and followed by soaking in Phosphomidan 85 EC at 1 ml/litre for 15 minutes.

Yield

6 – 8 t/ha.

Tamarind

Tamarindus indicus L.

Caesalpiniaceae

Varieties

PKM 1, Urigam, Hasanur and Tumkur.

Season

June - December.

Spacing

8-10m x 8-10m.

Planting

The grafts should be planted in the pits of 1 m x 1 m x 1 m filled with FYM and top soil. Add 50 g of Lindane 1.3% dust in the pit. Immediately after planting, support the graft with stakes.

Irrigation

Regular watering should be given till the plants establish well in the field.

Fertilizers

It is a dryland crop and generally not manured. Responds to organic manure.

Aftercultivation

1. Remove the rootstock sprouts.
2. Remove the dried and diseased parts
3. Intercrops may be raised in the alley spaces upto four years.

Plant protection

Pests

Leaf caterpillar *(Achaea janata)*

Spray Endosulfan 35 EC 2 ml/lit or Monocrotophos 36 WSC 2 ml/lit.

Storage beetle *(Pachymeres gonagra)*

Spray Endosulfan 1 ml/lit at the time of fruiting season.

Diseases

Powdery mildew

Spray Dinocap 1 g/lit.

Yield

Pods are harvested in March-April every year. 150 - 200 kg/tree/year.

Turmeric

Curcuma domestica Val.

Zingiberaceae

Varieties

Co 1, BSR 1, Roma, Swarna, Sudarshana, Suguna, Sugandham, BSR 2, Ranga, Rashmi, Rajendra Sonia, Krishna, Suroma and Allepy finger turmeric.

Soil and climate

A friable well drained red loamy soil in wet or garden lands under tropical conditions ideal.

Season

May-June

Seeds and sowing

Mother rhizomes are better yielders than finger rhizomes.

Seed rate

1500-2000 kg rhizome/ha.

Spacing

The rhizomes are to be dibbled in the sides of ridges, 45 cm apart at 15 cm spacing at a depth of 4 cm.

Manures and manuring

Basal

FYM 10 t,/ha neem or groundnut cake - 200 kg/ha, N, P and K at 25, 60 and 18 kg; 30 kg of Fe SO_4 and 15 kg $ZnSO_4$. 10 kg in each of *Azospirillum* and *Phosphobacterium* per ha to be applied after one month.

Top dressing

N, K at 25 and 18 kg/ha applied on 30, 60, 90, 120 and 150 days after planting.

Micronutrient application

For correcting deficiency of micronutrients especially Boron, Iron and Zinc at rhizome development stage, apply 375 g Ferrous sulphate, 375 g Zinc sulphate, 375 g Borax, 375 g of Urea in 250 lit of water/ha. Spraying twice at 25 days interval is recommended. The above micronutrients are dissolved in Super phosphate slurry (15 kg Super Phosphate is dissolved in 25 lit of water stored overnight and the supernatant solution is made upto 250 lit). In this solution, the micronutrients are added.

Intercultivation

Onion, Coriander and Fenugreek can be planted as intercrop on the sides of the ridges 10 cm apart (250 kg seed Onion per ha) Redgram and Castor can also be planted at wider spacing. One weeding after three weeks and whenever weeding is necessary. The plants are earthed up at the time of 2nd and 4th top dressings.

Plant protection

Pre planting treatment

The seed rhizomes are dipped in Carbendazim 1 g/lit and Phosalone 35 EC 2 ml/lit or Monocrotophos 36 WSC 1.5 ml/lit for controlling rhizome rot and scales.

Pests

Thrips

Spray Dimethoate 30 EC or Methyl demeton 25 EC 2 ml/litre.

Rhizome scale

Apply well rotten sheep manure @ 10 t/ha in two splits (once basally and other at earthing

up) or Poultry manure in 2 splits followed by drenching Dimethoate 30 EC 2 ml/lit or Phosalone 35 EC 2 ml/lit or application of Carbofuran 3 G @ 1.5 kg a.i./ha.

Seed rhizomes are dipped in Phosalone 35 EC 2ml/lit or Monocrotophos 36 WSC 1.5 ml/lit and then stored.

Nematode

Avoid planting Turmeric after Banana or other solanaceous vegetables. Plant only after taking suitable control measures. Apply Carbofuran 4 kg a.i./ha twice on the third and fifth month after planting the rhizomes.

Diseases

Rhizome rot

Drench with Bordeaux mixture 1 % or Copper oxychloride 0.25 %. Treat the seed rhizomes with 0.3% Copper oxychloride for 30 min before storage.

Leaf spot

Spray Carbendazim 500 g/ha or Mancozeb 1 kg/ha or Copper oxychloride 1.25 kg/ha.

Harvest

The plants will start lodging in about nine months. Yellowing and drying of leaves are the signs of crop maturity. The rhizomes are picked after digging deeply with mammuttis or digging forks.

Yield

Fresh rhizomes	:	25-30 t/ha
Cured rhizomes	:	5-6 t/ha

Storage of seed rhizomes

Seed rhizomes can be stored in open sand media with a partially closed pandal.

Ginger

Zingiber officinale Rosc.

Zingiberaceae

Varieties

Rio de Janeiro, Maran, Nadan, Suruchi, Surabi, Suprabha and Surati.

Season

April – May.

Soil and climate

A friable well drained loamy soil rich in humus with warm and humid conditions with 150 cm of annual rainfall are preferable. Grown as an irrigated crop in humid zones from sea level to an altitude of 1500 metres.

Seed rate

1500 - 1800 kg of rhizome/ha.

Spacing

For irrigated crop, ridges are formed 40 cm apart and rhizomes planted at 20 cm spacing.

Manures and Manuring

Basal

FYM 40 t, 50 kg P and 25 kg K/ha.

Top dressing

37.5 kg N and 12.5 kg K/ha each applied on 45th and 90th day.

Aftercultivation

Mulching is done at the time of planting with green leaves. After each top dressing, earth up the plants.

Plant protection

Pests

Shoot borer

Spray Dimethoate 30 EC 2 ml/lit or Phosphamidon 86 WSC 1 ml/lit.

Leaf roller

Spray Carbaryl 50 WP 2 g/ha or Quinalphos 25 EC 2 ml/lit.

Diseases

Soft rot (*Pythium* sp.)

Lack of drainage and continued dampness expose the plants to infection. The disease spreads through the seed rhizomes and soil. Provide adequate drainage facilities and select healthy and disease-free seed rhizomes and pre-treat the seed rhizomes. In the field drench the bed with 2.5

g/lit of Copper oxychloride or 1% Bordeaux mixture or Metalaxyl-mancozeb 4 g/lit. Treat the seed rhizomes with Mancozeb or Copper Oxychloride 3 g/lit or 200 ppm Streptocycline for 30 minutes before storage.

Leaf spot

Spray with 1 % Bordeaux mixture or Copper oxychloride 0.25%.

Harvest

The crop can be harvested after 8 - 9 months when leaves start yellowing and drying.

Yield

12 - 15 t/ha.

Fennel

Foeniculum vulgare Mill.

Apiaceae

Varieties

Co 1 and Co 2.

Soil and climate

Well drained loamy soil or black or sandy soil rich in organic matter is suitable. It comes up well in fairly mild climate.

Seed rate

For direct sowing	:	9 - 12 kg/ha.
For transplanting	:	3 - 4 kg/ha – Nursery area 100 sq.m.

Spacing

5 - 6 weeks old seedlings are transplanted at 60 x 30 cm spacing.

Seasons for sowing

Hills

May - June.

Plains

October - November.

Irrigation

First irrigation immediately after sowing, second on the third day and subsequent irrigations at 7 - 10 days intervals.

Manuring

Basal

FYM 10 t/ha, N at 25 kg and 10 kg P/ha.

Top dressing

25 kg N at the time of flowering.

Aftercultivation

Two or three weedings are necessary. The plants are earthed up after 3 months. Pre-emergent application of Pendimethalin @ 1 kg a.i./ha and one hand weeding.

Plant protection

Pests

Aphids

Spray Dimethoate 30 EC 2 ml/lit or Methyl demeton 25 EC 2 ml/lit.

Powdery mildew

Dust Sulphur at 25 kg/ha at the time of appearance of disease.

Harvest

The crop matures in 7 - 8 months. Harvest the umbels 4 - 5 times at 10 - 15 days intervals, dry in sun for 4 - 5 days and seeds are threshed.

Yield

500 - 750 kg/ha/year.

Fenugreek

Trigonella foenum graecum L.

Leguminosae

Varieties

Co 1 and Pusa Early Bunching.

Soil

A rich well drained loamy soil is best suited.

Season

June - July and October - November.

Seeds and Sowing

The field is prepared to a fine tilth, beds of 3.5 x 1.5 m are formed, and seeds are sown.

Seed rate

12 kg/ha.

Manuring

Basal

FYM 20 - 25 t/ha and N, P, K at 30:25:40 kg/ha.

Top dressing

20 kg of N at 30 days after sowing.

Irrigation

Give first irrigation immediately after sowing, second on the third day and subsequently at 7 - 10 days intervals.

Aftercultivation

Plants are thinned at 20 - 25 days after sowing and the thinned seedlings are used as greens. One pinching at a height of about 4" will encourage branching. Pre-emergence spray of Fluchloralin 700 ml in 500 lit water/ha and subsequent weeding are done whenever necessary.

Plant protection

Diseases

Root rot

Drench with Carbendazim 0.5 g/lit or PCNB 1 g/lit or seed treatment i.e. *Trichoderma viride* @ 4 g/kg and also soil application of Neem cake 50 kg/ha. first at the onset of the disease and another after one month.

Crop duration and harvest

20 - 25 days for greens.

90 - 100 days for grains.

Yield

The yield of green is	:	4000 - 5000 kg/ha.
Grains	:	500 - 700 kg/ha.

Chapter C - Minor Spice crops

Name (Botanical name)	Method of propagation	Spacing	Manurial recommendation	After cultivation and special practices if any	Cropping and harvest	Yield
All spice (*Pimenta officinalis* Lindl.)	Six months old seedlings. Hard wood cuttings	6 x 6 m	-	Weeding and hoeing whenever needed	Harvest season July - August. Harvest when the berries are fully mature but unripe. Cured by sun drying till the berries become crisp and produce a metallic sound.	50 - 60 kg of dry berries/tree. **Remarks**: Economic part: Dried fruits, Dried leaves are used for flavouring.
Mustard (*Brassica juncea* (L) *Czenjajer.*)	Seed 6 - 7 kg/ha	45 x 30 cm in beds	Basal: FYM 25 t N 25 kg, P 60 kg. Top dressing: N 25 kg	2 - 3 weedings	Duration: 3 - 4 months. Plants pulled after pods turn brown, dried in the sun and threshed.	1000 - 1200 kg/ha
Vanilla (*Vanilla planifolia*)	Stem cuttings (90 - 100 cm long)	1.5 x 1.5 m in hills of the standards	-	Weeding and hoeing in the basins. Train the vines horizontally in trellis at 2.5 m height.	The fully grown pods are harvested when the tips turn yellow. Curing of the pods is done subsequently.	500 - 800 kg of Vanilla cured beans per ha pods. **Remarks:** Vanilla is extracted from seeds and pods.

Part IV

Plantation Crops

Tea

Camellia sinensis L. O. Kuntze.

Camelliaceae

Varieties

Pandian, Sundaram, Golconda, Jayaram, Evergreen, Athrey, Brookeland, Biclonal seed stocks 1 - 5 and Grafts.

Soil and climate

Tea requires well drained soil with high amount of organic matter and pH 4.5 to 5.5. The performance of tea is excellent at elevations ranging from 1000 - 2500 m.

Nursery

The nursery soil should be well drained and deep loam in nature with pH of 4.5 to 4.8. The soil and sand, which are to be used in the preparation of rooting medium, should be tested for pH and nematode infestation.

Pre-treatment of rooting medium

Treating with Aluminium sulphate can reduce soil pH. For this purpose the nursery soil is formed into beds of one metre width and about 8 cm height and of a convenient length. Then the beds are drenched with 2% solution of Aluminium sulphate applied at 10 litres per 2.5 sq.m of area. Over this another layer of soil of 8 cm height is spread and again drenched with equal quantity of water twice. Then the soil is allowed to dry and the pH is checked before use in the nursery.

Preparation of sleeves

Polythene sleeves of 150 or 200 gauge and 10 cm width and 30 - 45 cm length may be used. Drainage holes may be provided. The lower 3/4 of the sleeves should be filled with 1:3 sand and soil mixture and the top 1/4 with 1:1 sand and soil mixture and staked in rows. Overhead shade is provided.

Selection of mother bush and its treatment

Healthy and vigorously growing high yielding bushes should be selected. Apply to each

selected bush, 40 g of young tea mixture 60:90 NK mixture upto 5 years. In addition, 3 weeks before 0.5 % Al SO_4 + 1 % Mg SO_4; 2 weeks before 2 % Zn SO_4; 1 week before 1 % Urea.

Preparation of cuttings

Cuttings are taken on April - May and August - September. Semi hard-wood cuttings are prepared with one full leaf and an internode with a slanting cut at the bottom.

Planting of cuttings

The sleeves are watered thoroughly and holes are made in the soil. The cuttings are inserted in the hole and the soil around is pressed firmly to avoid airspace followed by watering. Small polythene tents may be provided which maintain high humidity and regulate the temperature inside. Cuttings may take 10 - 12 weeks for rooting. After 90 days i.e. when all the cuttings have rooted, the polythene tent may be removed gradually over a period of 10 - 15 days.

Manuring of nursery

After the tent is removed the cuttings are sorted and staked. 30 g of Nursery soluble mixture of the following composition dissolved in 10 litres of water may be applied over an area of 4 sq.m. This should be done fortnightly.

Composition of the fertilizer

Ammonium phosphate (20:20)	35 parts by Wt
Potassium sulphate	15 parts by Wt
(or) MOP	12 parts by Wt
Magnesium sulphate	15 parts by Wt
Zinc sulphate	3 parts by Wt
Total	**80 parts by Wt**

Hardening of the cuttings

Hardening of 4 - 6 months old young cuttings should be done by removing shade gradually in stages over a period of 4 - 6 weeks starting from a few hours exposure to sun every day initially and extending the time of exposure gradually.

Methods of planting

Single Hedge System

In this method the spacing is 1.20 x 0.75 m accommodating 10,800 plants/ha.

Double Hedge System

In this method, the spacing is 1.35 x 0.75 x 0.75 m accommodating 13,200 plants/ha.

Season and planting

May - June or September - October.

Sleeves should be opened lengthwise without injuring the roots and planted in the pit and the soil is gently pressed.

Irrigation

Subsoil irrigation may be given for young teas during summer months.

Manuring

Manuring should be done 2 months after planting. Phosphorous should be applied at 80 - 100 kg/ha as Rock phosphate once in a year by placement at 15 - 25 cm depth upto the first pruning and thereafter once in two years. N : K ratio 2 : 3 should be adapted for the first 3 years and a ratio 1 : 1 thereafter.

Year of application	Total weight Kg/ha/annum		No. of application	Qty / plant (g)	
	N	K		Ammonium Sulphate	Urea
I year	180	270	5	13	27
II year	240	360	6	23	15
III year	300	450	6	29	18
IV year onwards	300	300	6	33	19

Application of fertilizers should be done before the onset of monsoon. Fertilizers should be broadcast around the drip circle avoiding contact with the collar.

Aftercultivation

Control perennial grasses by spraying Glyphosate 1.75 lit + Kaoline 2 lit + 2 kg of wetting agent in 450 lit. of water followed by Gramoxone 500 ml in 200 lit of water to control dicot weeds.

Training young tea

Centering

To induce more laterals centering should be done 3 - 5 months after planting. The main leader stem should be cut, leaving 8 - 10 matured leaves.

Tipping

Tipping at a height of 35 cm from the second tipping at 60 cm from ground level.

Pruning

To maintain convenient height and vegetative growth and to remove dead and diseased branches

Area to be pruned every year = $\frac{\text{Total extent of the garden}}{\text{Pruning cycle}}$

Pruning interval = (Elevation in feet / 1000) + 1

Pruning should be done in April - May or August - September.

Types of pruning

Rejuvenation pruning

The whole bush should be cut near the ground level less than 30 cm with a view to rejuvenate the bushes.

Hard pruning

Formation pruning of young tea at 30 to 45 cm (12" to 18") for proper spread of bushes.

Medium pruning

To check the bush growing to an inconvenient height this type of pruning is done in order to stimulate new wood and to maintain the foliage at lower levels less than 60 cm.

Light pruning

Pruning depends on the previous history of the bush raising the height of medium pruning by an inch or less to manageable heights for plucking (less than 65 cm).

Skiffing

This is the lightest of all pruning methods. A removal of only the top 5 - 8 cm new growth is done so as to obtain a uniform level of pruning surface (more than 65 cm).

Shade regulation

Pollarding of shade trees should be done prior to heavy rains at a height of 8 - 10 m from the ground level.

Annual lopping

Cutting the erect type branches on the laterals in shade trees.

Plant protection

Scales

Spray Carbaryl 2 g/lit. or Endosulfan 35 EC 2 ml/lit or Quinalphos 2 ml/lit, or Chlorpyriphos 20 EC 2 ml/lit.

Sahyadrussus borer

1) Locate the particle mat covering at the base tea bush and remove.
2) Insert a thick wire in the bore hole to kill the larvae.

3) Pour quinalphos 25 EC by an ink filler inside the borehole and close it with moist clay.

Thrips and Aphids

Spray Phosalone 35 EC or Endosulfan 35 EC 2 ml/lit.

Mites

Spray Dicofol 18 EC 2 ml/lit and Sulphur 40 % 2 g/l, Sulphur 80 % 1 g/l or Ethion 50 EC 1 ml/lit.

Diseases

Blister blight

1) Spray 210 g Copper oxychloride and Nickel chloride per ha at 5 days interval from June - September; 11 days intervals in October and November.
2) Hexagonazole 200 ml + Copper oxychloride 210 g 5 days interval/ha.
3) Copper oxychloride 210 g + 200 ml Propiconazole/ha 10 days interval.

Crop duration and harvest

Plucking commences when the tea bush is 3 years old. The plucking of extreme tip of the growing branch consists of an unopened bud together with two leaves is popularly known as "Two leaves and a bud" while fine plucking is anything less than this. Plucking continues throughout the year in South at weekly intervals during March - May and at intervals of 10 -14 days during the other months.

2 – 3 leaves with a bud – 7 to 10 days interval – rush period.

10 – 15 days interval – lean period.

Yield

The yield of green leaves is 10 t/ha.

Coffee

Coffea canephora Pierre ex Frechna. *Coffea arabica* L.

Rubiaceae

Varieties

Arabica varieties

Sln 795, Sln 7, Sln 9, Sln 10, Cauvery and its selections and HRC. (Hawaian Red Cuturra)

Robusta varieties

Sln 274.

Soil and climate

Soil should be deep, friable, open textured rich in plant nutrients with plenty of humus and of neutral reaction. It grows up well from 500 m to 1650 m MSL with a well distributed rainfall of 150 to 200 cm annually. Definite wet and dry season are essential to have a well marked cycle of flowering. A blossom shower during March - April and a back up shower during May - June is essential for successful crop.

Seeds and sowing

Coffee is propagated by seeds.

Season

June - December.

Preparation of seeds

Healthy and well developed fully ripe berries are harvested from specially identified plants for use as seed bearers. After discarding the floats, the sound fruits are depulped, sieved and mixed with sieved wood ash and dried in shade. The seed is then graded to remove all cut, triangular and elephant beans. Prior to planting, the seeds are treated with Agrosan or any Organomercurial compound to prevent fungal infection.

Nursery practices

Select light loamy soil of good drainage and high organic matter content with water and shade facilities. Form raised beds of 15 cm height, 1m width and at convenient length. Incorporate 30 - 40 kg of well rotten compost, 2 kg of finely sieved agricultural lime and 400 g of rock phosphate to a bed of 1 x 6 m size. In heavy soils, it is necessary to add coarse sand for drainage and aeration.

Sowing

Pre-sowing seed treatment with *Azospirillum* and *Phosphobacterium* can be done.

Seeds are sown in December - January in the bed 1.5 - 2.5 cm apart with the flat side down wards in regular rows. Then they are covered with a thin layer of fine soil and a layer of paddy straw. Water the beds daily and protect from direct sunlight by an over head pandal. Seeds germinate in about 45 days after which they are transplanted to a secondary nursery beds for raising ball or Bag nursery.

Bag nursery

Polythene bags with adequate number of holes in the bottom half are taken and are filled with a prepared mixture containing jungle soil, FYM and in the proportion of 6:2:1. An area of 12 x 8 m can accommodate 5000 seedlings. Seedlings are planted in polythene bags. Seeds can be treated with *Phosphobacterium*.

Preparation of field

Selective felling may be done while retaining a number of desirable shade trees. Terracing

should be done in deep slopy areas. After the summer showers, pits of 45 cm x 45 cm x 45 cm are dug at 1.25 - 2.5 m apart. The pits are left open for weathering and then filled and heaped for planting. At the time of filling, apply 500 g of rock phosphate per pit along with top soil. Planting is done along the contour in slopy areas.

Planting shade trees

Dadap is commonly used as a lower canopy shade. Two metre long stakes are planted for every two plants of coffee. Silver Oak and Dadaps are planted during June when rains of South-West monsoon commences. During summer the stem of young Dadaps are painted with diluted lime or wrapped in agave leaves or polythene sheets in order to prevent them from sun scorch. Regulate shade by cutting criss-cross branches during monsoon season. Silver oak trees are planted for permanent shade.

Spacing

Arabica Coffee

1.5 to 2.0 m either way.

Dwarf varieties

Sanraman : 1 x 1 m.

Robusta coffee

2.5 m either way.

Irrigation

It is generally grown as a rainfed crop. But irrigation with sprinkler during March - April increases blossoming and results in higher yields.

Aftercultivation

Weeding and mulching should be done as and when necessary. Digging is done to a depth of 30 cm towards the end of monsoon (October - November). The weeds and vegetative debris are completely turned under and buried in the soil while the stumps are removed. This is known as the cover digging. In slopy areas dig trenches on the contour 45 cm wide and 30 cm deep of any convenient length. Prune water shoots and disease affected shoots.

Plant protection

Pests

White stem borer

Attacks arabica coffee grown under inadequate shade. Swab with 2 kg Lindane 20 EC in 180 lit of water. Padding with Monocrotophos 36 WSC 5 ml by making a window in the stem at 5 cm^2 and filling it with absorbant cotton dipped in insecticide solution and close it.

Shot hole borer beetle

Attacks branches and suckers of robusta coffee. This pest thrives under heavy shade and can be controlled by pruning the branches and spraying with Endosulfan 2 ml/lit.

Cockchafer beetles/White grub

Systemic insecticide like Phorate 10% G can be applied.

Green scales and mealy bugs

Spray Quinalphos 25 EC 2 ml/lit or Fenthion 1 ml/lit or Fenitrothion 1 ml/lit. Release coccinallid predator *Cryptolaemus montrouzieri* @ 300 beetles/acre. Spray *Verticillium lecanii* @ 6×10^6 spores/ml.

Diseases

Rust

Spray 0.5% Bordeaux mixture in February - March (Pre-bloom) followed by 0.03% Oxycarboxin in May - June (Pre-monsoon). Repeat in July - August (mid-monsoon) September - October (Post-monsoon) with any one of the above fungicides.

Black rot or Koleroga

Centering and handling of the bushes should be done prior to the onset of South-West monsoon. Remove affected twigs. Spray 1% of Bordeaux mixture during break in monsoon.

Collar rot

Treat seeds with Carbendazim 1 g/kg or Carboxin 0.7 g/kg. Maintain filtered shade in nursery. Drench nursery beds with Mancozeb or Captan 0.5 g/lit before sowing.

Brown eye spot

Spray Captan or Mancozeb or Ferbam 2 g/lit or Carbendazim 0.5 g/lit in September.

Black root rot

Dig out and burn infected bushes. Dig a trench 30 cm deep around affected spot along with a ring of healthy bushes. Prune the healthy bushes within and outside the trench to allow sunlight. Keep the trench free from fallen leaves. Do not replant for 18 months.

Harvest

Harvest starts during November and harvesting extends upto February. Coffee fruits should be harvested as and when they become ripe. Coffee is just ripe when on gently squeezing the fruits the beans inside come out easily. Unripe fruits should be scrupulously sorted out before using the fruits for pulping. They may be dried separately as cherry.

Yield

Dry parchment 750 - 1000 kg/ha.

Rubber

Hevea brasiliensis Muell-Arg.

Euphorbiaceae

Varieties

Tjir 1, PB 86, BD 5, BD 10, PR 17, GT 1, RRII 105, RRIM 600, PB 28/59, PB 217, PB 235, RRIM 703, RRII 5, PCK-1, 2 and PB 260.

Soil and climate

It requires deep and fertile soil with pH of 4.5 to 6.0.

Season

June - July.

Planting

Propagated by green budding, brown budding and crown budding.

Planting

In the cleared forest area, pits at 1 m x 1 m x 1 m are dug and filled up with soil and compost. The spacing of 3 x 2 m or 5 x 5 m are adapted.

Seed at stake planting

Germinated seeds are sown *in situ* in the pits. Healthy ones are retained and the others removed.

Manuring

a. For immature rubber trees at pre-tapping stage

1. Apply 12 kg of compost or FYM and 120 g of rock phosphate in each pit before planting.
2. Apply 10:10:4:1.5 NPK and Mg as per schedule given below:

Months after planting	Period of application	Quantity per plant	
		10:10:4	12:12:6
3	September/October	225 g	190 kg
9	April/May	445 g	380 kg
15	September/October	450 g	380 kg
21	April/May	450 g	480 kg
27	September/October	550 g	480 kg
33	April/May	550 g	380 kg
39	September/October	450 g	380 kg

3. Apply 400 kg of mixture per ha in 2 doses, once in April/May and another in September/ October from the 5th year till the tree is ready for tapping.

b. Matured rubber trees under tapping

1. Apply NPK 12:6:6 mixture at the rate of 400 kg/ha every year in two split doses.
2. Add 10 kg commercial Magnesium sulphate for every 100 kg of the above mixture if there is magnesium deficiency.

Aftercultivation

Growing of cover crops, incorporation of cover crops and weeding are important operations. *Pueraria phaseoloides, Calopagonium muconoides, Centrosema pubescens* and *Desmodium evalifolium* are common cover crops.

Tapping

Trees attain tappable stage in about 7 years. First tapping in seedling trees will commence when the trunk attains a girth of 55 cm at 50 cm height from the ground. In budded trees the girth should be 50 cm at 125 cm height from the bud union.

Ethrel treatment

Ethrel is recommended to increase latex yield of trees tapped on panel D. It is applied at 5% a.i. concentration with a brush below the tapping cut to a width of 5 cm after light scraping of the outer bark. The first application may be done after a drought period preferably after a few pre-monsoon showers and subsequent applications may be done in September and November. However, continuous application of Ethrel is not recommended for periods of more than 3 years at a stretch.

Plant protection

Pests

Scale insect

When severe infestation is noticed, spray Organophosphorus insecticides like Malathion 50 EC 2 ml/lit.

Mealy bug

Spray fish oil resin-soap 25 g/lit. Release Austalian lady bird beetle, *Cryptolaemus montrouzieri* @ 10/tree.

Termite (White ant)

Drench the soil at the base of affected plants with Chlorpyriphos 20 EC 2 ml/litre.

Cockchafer grub

Drench soil at the base of plants in the affected area with the solution of Chlorpyriphos 20 EC 2 ml/litre.

Mites

Spray sulphur 50 WP at 2 g/lit or spray Dicofol 18 EC 2.5 ml/lit.

Diseases

Abnormal leaf fall

Prophylactic spraying of the foliage prior to the onset of South-West monsoon with,

1. Bordeaux mixture 1% at 4000 - 5000 lit/ha using high volume sprayers.
2. Oil based Copper oxychloride dispersed in diluent spray oil employing either low volume air blast sprayers (Micron 420 or Minimicron 77 or Shaw Duster Sprayer) from the ground or through aerial application.

For micron spraying on the tree spread, foliage intensity, planting material used and age of plants, two rounds of spray using about 17 to 22 lit of fungicide oil mixture per ha per round (1:6 proportion) with gap of 10 to 15 days or a single round of spray with about 30 - 37 lit of fungicide oil mixture per ha (1:5 proportion) may be necessary.

Secondary leaf fall

The control measures suggested for abnormal leaf fall will check this disease also.

Powdery mildew

Dusting during the defoliation period commencing from the bud break in about 10% of the trees, giving 3 to 5 rounds at weekly to fortnightly intervals before 10.00 a.m. using 11 to 14 kg 325 mesh fine Sulphur dust per round per ha. Sulphur dust can be mixed with talc in the proportion of 7:3. Wettable sulphur (1 kg in 4000 lit of water) is also effective in nurseries and for young plants as a spray.

Bird's eye spot

Repeated sprayings with Bordeaux mixture 1% or Mancozeb or Copper oxychloride 0.2%. Provide shade in nursery. Give balanced manuring to increase tree vigour.

Leaf spot

Spray 1% Bordeaux mixture or 0.2% Mancozeb, or 0.1% Carbendazim at fortnightly intervals.

Pink disease

Frequent tree to tree inspection during July – September period for detecting the infected trees and application of Bordeaux paste in the early stages upto 30 cm above and below the affected region. In advanced cases apply Bordeaux paste and when it dries up scrape off the superficial mycelium and damaged bark and apply Bordeaux paste once again. Prune off and burn the dried up branches after disinfecting by Bordeaux spraying.

Patch canker or Bark cankers

The affected region may be scraped to remove all the rooting bark and the coagulated rubber

and the wound washed well with Emisan solution. (Emisan 10 g in 2 lit). When the fungicide dries up apply wound dressing compound.

Dry Rot, Stump Rot, Collar Rot Or Charcoal Rot

Clean up affected areas, by washing with Emisan solution. Scrape out the fructifications. Affected bark and wood show black lines. Wash the wound again with fungicide solution. When it dries up apply a wound dressing compound. Avoid accumulation of rubber at the base of the trees. For root infection see the treatment for brown root disease.

Brown root disease

Open up the root system. Completely killed and dried roots may be traced and pruned. Partially affected and healthy roots washed with Emisan solution. When the fungicide dries up, a thin coating with a wound dressing compound may be given. Refill the soil and drench the base with fungicide solution.

Yield

Rubber yield steeply increases year by year, reaching a peak after 14 years of planting. In South India, the annual yield of rubber is 375 kg/ha from seedlings trees, whereas budded plants yield 800 - 1000 kg/ha.

Cashewnut

Anacardium occidentale L.

Anacardiaceae

Varieties

VRI 1, VRI 2 and VRI 3.

Soil and climate

It grows up well in all soils. Red sandy loam is best suited. Plains as well as hill slopes upto 600 - 700 feet elevation are suitable.

Season

June - December.

Propagation

Soft wood grafting, air layer and epicotyl grafting.

Requirement of plants

200 plants/ha.

Preparation of field

Pits of 45 cm x 45 cm x 45 cm size are dug and filled up with a mixture of soil + 10 kg FYM + one kg neem cake and 100 g Lindane 1.3 %.

Spacing

7 m either way.

Manuring (per tree)

Manures and fertilizers	I year old	II year old	III year old	IV year old	V year onwards
F.YM or Compost (kg)	10	20	20	30	50
N(g)	70	140	210	280	500
P(g)	40	80	120	160	200
K(g)	60	120	180	240	300

Fertilizer application may be done during November - December in the East Coast areas. Wherever possible the fertilizer can be applied in 2 equal split doses during June-July and October-November periods.

Intercropping

Plough the interspaces after the receipt of rain and raise either groundnut or pulses or minor millets till the trees reach bearing age.

Training and pruning

Develop the trunk to a height of 1 m by removing low lying branches. The dried twigs and branches should be removed every year.

Plant protection

Pests

Stem borer

- Collection and destruction of affected shoots.
- Swabbing the bark of exposed roots and shoots with Carbaryl 50 WP 0.1 %
- Twice a year before the onset of South West Monsoon (March – April) and after cessation of monsoon (November) painting of coal tar + kerosene mixture (1:2) or swabbing with a suspension of 0.2% Carbaryl 50 WP upto one metre length in the exposed trunk region after shaving the bark.
- Root feeding with Monocrotophos 36 WSC 10 ml + 10 ml of water kept in a polythene

bag on one side of the tree and keep the same amount on the other side of the tree (Total 20 ml/tree) divided into two equal halves will give protection when there is moderate incidence.

Swab the trunk with Lindane 20 EC 1 ml/lit or Carbaryl 50 % WP 500 g in 20 lit of water.

Tea mosquito bug

Spray Endosulfan 35 EC 1.5 ml/lit + Urea 3 % thrice. The first at the time of emergence of new flushes, the second at floral formation and the third at fruit-set.

Shoot caterpillars

Spray Endosulfan 35 EC 2 ml/lit.

Root borer

Pour Monocrotophos 10 ml/tree in the bore holes split into two halves (insecticide 5 ml + 5 ml water).

Diseases

Die back or Pink disease

Prune the affected shoots just below the affected portion and apply Bordeaux paste. Spray 1 % Bordeaux mixture or any copper fungicide like Blitox or Fytolan 0.25 % twice i.e. in May - June and again in October as a prophylactic measure.

Harvest

The peak picking months are March and May. Good nuts are grey green, smooth and well filled. After picking, the nuts are separated from the apple and dried in the sun for two to three days to bring down the moisture content to 10 to 12 %. Properly dried nuts are packed in alkathene bags. This will keep for 6 months.

Yield

3 - 4 kg/tree/year.

Arecanut

Areca catechu L.

Palmae

Varieties

Mangala, Sumangala, Subamangala, Mohitnagar and Srimangala.

Soil and climate

Arecanut is capable of growing in a variety of soils. It thrives best in well drained soils. Adequate protection from exposure to South-Western sun is essential to avoid sun-scorch. Quick growing shade trees have to be planted on the southern and western sides well in advance of planting seedlings. It is sensitive to moisture deficit and should be grown where adequate water facilities are available.

Season

June - December.

Seeds and sowing

For raising seedlings seed nuts from pre-marked and pre-potent mother palms of outstanding performance are selected and sown at a spacing of 5 - 6 cm apart in sand beds under partial shade with their stalk end pointing upwards. After the sprouts have produced two to three leaves, they are transplanted to a polythene bag 30 x 10 cm filled with forest soil and are allowed to grow for 12 to 18 months under partial shade. The seedlings can also be transplanted in secondary nursery beds with a spacing of 30 cm on either side. Periodical watering should be given.

Planting

Dwarf and compact seedlings with more number of leaves should be selected. Seedlings of 1 - 2 years age are planted in pits of about 90 cm x 90 cm x 90 cm at a spacing of 2.75 m either way and covered with soil to the collar level and pressed around. Provide shade during summer months. Growing Banana or other crops in advance may also provide shade.

Irrigation

Irrigation should be given as and when necessary.

Manuring

Apply to each bearing palm (5 years and above) 10 - 15 kg of FYM or green leaf. 100 g N, 40 g P and 150 g K. To palms less than five years old, half of the above dose is recommended. Manures are applied during January - February after the North - East monsoon in a basin of 0.75-1.00 m radius around the tree to a depth of 20 - 30 cm.

Aftercultivation

Weeding is done twice or thrice a year by giving mammutti digging. Wherever the land is slopy terracing has to be done to prevent soil erosion.

Plant protection

Pests

Mites

Dicofol 18 EC at 2.5 ml/lit.

Spindle bug

The spindles may be given a drenching spray with Lindane 1.3% @ 2.5 g/lit of water.

Inflorescence caterpillars

Spray with Lindane 20 EC 2 ml/lit or WP @ 2.5 g in one litre of water.

Diseases

Bud rot or Mahali disease

Infected tissues of the bud should be scooped off and treated with 10 % Bordeaux paste. Destruction and removal of seed palms and also bunches affected by Mahali and drenching crowns of surrounding healthy palms with 1 % Bordeaux mixture would help in minimising the incidence of the disease.

Foot rot or anabe

Affected palms have to be isolated by digging trenches all round. The severely affected palms should be cut and destroyed. The stumps should be pulled out by digging and the drainage improved.

Root feeding with 125 ml of 1.5 % (15 ml/litre of water) Tridemorph at 3 months interval.

Stem breaking

Wrapping up of the green portion of the stem which are exposed to the South-West sun to protect against sun-scorch.

Harvest

The bearing starts after 5 years of planting. Nuts are harvested when they are three quarters ripe. The number of harvests will vary from three to five in one year depending upon the season and place of cultivation.

Yield

1250 kg/ha.

Cocoa

Theobroma cacao L.

Sterculiaceae

Varieties

Criollo, Forestero and Trinitario.

Soil and climate

Potash rich alluvial soils friable in nature with high humus and moisture retentivity with a pH of 6.6 - 7.0 are suitable. Cocoa is normally cultivated at altitudes upto 1200 m with an annual rainfall of 150 cm and a relative humidity of 80 % and annual mean temperature of 24°C to 25°C. Cocoa can be grown as intercrop in coconut and arecanut gardens.

Season

June - July and September - October.

Seeds and sowing

Cocoa is normally propagated by seed. Before sowing the seeds the pulp adhering to the seeds has to be removed. Cocoa seeds are individually sown in polybags soon after extraction. The bags are filled with surface soil and sub-soil mixed with compost, leaf mould and fertilizers. Nursery plants are ready for transplanting at 6 months of age when they attain a height of 60 cm.

Planting

Seedlings are transplanted with a ball of earth in 45 cm x 45 cm x 45 cm pits at a spacing of 3 x 3 m either way. Periodical mulching with leaves and watering should be done. Temporary shade has to be provided.

Irrigation

Irrigation should be given as and when necessary. During summer months irrigation should be given once in three days.

Manuring

Trees of 3 years of age and above are manured with 100 g N, 40 g P and 140 g K per tree in two split doses during April - May and August - September. Trees younger than three years may be applied with half of this dose.

Aftercultivation

Weeding is done as and when necessary. The unproductive shoots, dead, diseased twigs should be removed periodically. Banana is better as a primary shade plant in the early years of plantation. For permanent shades Jack, Silver Oak, etc. are planted.

Plant protection

Pests

Mealy Bug

Spray Phosphamidon 85 EC 1 ml/lit or Dimethoate 2 ml/lit at fortnightly intervals. Release coccinellid predator *Cryptolaemus montrouzieri* @ 10 tree.

Aphids

Spray Dimethoate 35 EC 1 ml/lit at monthly intervals.

Grey Weevil

Spray Phosphamidon 85 EC 1ml/lit.

Hairy caterpillar

Dust Lindane 1.3 % or spray Lindane 20 EC 2ml/lit.

Semilooper

Dust Lindane 1.3 %.

Diseases

Black pod disease

Spray 1 % Bordeaux mixture or 0.2 % Mancozeb or Copper oxychloride at 20 days interval.

Dieback disease

The disease can be controlled by spraying 1 % Bordeaux mixture.

Charcoal disease

Spray with 1 % Bordeaux mixture.

Pink disease

Prune the affected branches and swab the cut ends regularly with 1 % Bordeaux mixture.

Harvest

Bearing starts from 4th year but economic yield starts from 6th year onwards. The season of harvest is November - December and May - June.

Yield

The yield ranges from 500 - 1000 kg of dry beans/ha.

Betelvine

Piper betel

Piperaceae

Varieties

Karpurakodi, Kallarkodi, Revesi, Karpuri and SGM 1.

Soil and climate

Well drained fertile clay loams are suitable. It does not tolerate saline and alkaline conditions. Betelvines require a cool shade, considerable humidity and regular supply of moisture in the soil.

Seeds and sowing

The vines are propagated by terminal stem cutting or setts about 30 - 45 cm long. Setts obtained from the top portions of the vines are easy to root and hence best for planting. Number of setts 1,00,000/ha. Setts with vigorous apical buds and nodal adventitious roots are selected and planted at the base of the live supports, which are to be planted 4 to 5 months earlier.

Season

November - December and January - February.

Preparation of field

The field is prepared to a fine tilth and beds of 2 m wide are formed to a convenient length. Provide drainage trenches of 0.5 m width by 0.5 m depth in between two adjoining beds. Plant the seeds of the live supports i.e. Agathi (*Sesbania grandiflora*) in long rows. About 750 banana suckers are planted at the edges of the beds, which are used, for tying the vines on the live support and for packing the betel leaf. When the Agathi supports grow to a height about 4 m they are topped. The crop is planted in two rows in beds of 180 cm width on Agathi plants with a spacing of 45 cm between plants in the row.

Irrigation

Irrigate the field immediately after planting and afterwards once in a week.

Aftercultivation

Training of the live Standards

Before the establishment of vines the side branches of Agathi trees upto a height of 2 m are removed for early creeping of the vines.

Training of the vines

Training is done by fixing the vine at intervals of 15 to 20 cm along the standards loosely with the help of banana fibre. Training is done every 15 - 20 days depending upon the growth of vines.

Lowering of vines

Under normal cultivation, the vines grow to height of 3 m in one year period. When they reach this height their vigour to produce normal size leaf are reduced and they need rejuvenation by lowering during March - April. After the vine is lowered a number of tillers spring up from the nodes at the bends of the coiled vines at the ground level and produce many primary vines. After each lowering irrigation should be given.

Manuring

Apply 150 kg N/ha/year through Neem cake (75 kg N) and Urea (75 kg N) and 100 kg P_2O_5 through Super phosphate and 30 kg Muriate of potash in three split doses first at 15 days after lifting the vines and second and third dose at 40 - 45 days intervals. Apply on beds shade dried neem leaf or *Calotrophis* leaves at 2 t/ha and cover it with mud (2 t in 2 split doses).

Plant protection

Pests

Scale insects

Select scale-free seed vines. Spray Chlorpyriphos 20 EC 2 ml/lit when one or two scales are noticed on the basal portion of the stem/leaves. Direct the spray solution to the basal portion of the vines. Spray NSKE 50 g/lit or Malathion 50 EC 1 ml/lit.

Mites (Sevvattai)

Spray Wettable sulphur 50 % WP @ 1 g/lit or Dicofol 18 EC 0.5 ml/lit.

Sooty mould (Aphids)

To control aphids spray Chlorpyriphos at 2 ml/lit on Agathi leaves. Clip off excess Agathi leaves.

Mealy bugs

Spray Chlorpyriphos 20 % EC at 2 ml/lit or Dimethoate 30 EC 2ml/lit. Concentrate the spray towards the collar region.

Nematode

Application of Neem cake at 1 t/ha or chopped and shade dried *Calotrophis* leaves at 2.5 t/ha to soil, after lowering the vines.

Diseases

Phytophthora Wilt

Integrated method for the management of *Phytophthora* wilt.

a) Select well matured (more than 1 year old) seed vines free from pest and diseases.

b) Soak the seed vines for about 30 minutes in Streptocyline 500 ppm or Bordeaux mixture 0.5 %.

c) Apply 150 kg N/ha/year through Neem cake (75 kg N) and Urea (75 kg N) and 100 kg P_2O_5 through Super phosphate and 30 kg Muriate of potash in 3 split doses first at 15 days after lifting the vines and second and third dose at 40 - 45 days intervals. Apply on beds, shade dried neem leaf or *Calotrophis* leaves at 2 t/ha and cover it with mud (2 t in 2 split doses).

d) Drench Bordeaux mixture 0.25% in basins formed around the vine at monthly intervals starting from October – January, three times soil drench and six times spray from June - July.

e) During winter season avoid frequent irrigation.

f) Remove the affected vines away from the garden and burn them.

g) Application of Alliette 3 g/lit 4 times monthly intervals.

h) Application of *Trichoderma viride* @ 5 g/vine.

Bacterial leaf spot, blight and bacterial stem rot

Spray Streptocyline 400 ppm + Bordeaux mixture 0.25% when the first disease symptoms appear. Continue spraying at 20 days intervals. Always spray the chemical after plucking the leaves.

Anthracnose (Theechal)

Spray 0.2% Ziram or 0.5% Bordeaux mixture after plucking the leaves after the first appearance of the symptom. The variety Karpoori is susceptible to the disease.

Powdery mildew

Spray 0.2% Wettable sulphur after plucking the leaves.

Harvest

It depends upon the growth of the vines and market condition. Once harvesting starts it continues almost every day.

Yield

75 to 100 lakh leaves/ha/year.

Part V

Medicinal and Aromatic Plants

Chapter A

Medicinal Plants

Senna

Cassia angustifolia Vahl.

Leguminosae

Varieties

Local and ALF-T2.

Soil and climate

In Tamil Nadu, it is grown in sandy or sandy loam or laterite soils. It is a hardy warm weather crop grown under rainfed and irrigated conditions.

Seed rate

15 - 20 kg/ha.

The seeds are scarified with sand or can be soaked overnight in water and sown in beds at a spacing 45 x 30 cm during February – March or June – July.

Season

February - March and June - July.

Manuring

Basal

Apply FYM 10 - 15 t/ha and N, P and K at 25, 25 and 40 kg/ha.

Top dressing

Apply 25 kg N two splits at 40 and 80 days after sowing.

Aftercultivation

One or two weedings.

Plant protection

Pests

Aphids

Spray Dimethoate 30 EC or Methyl demeton 25 EC at 1 ml/lit of water.

Harvest

The first harvest of leaves and pods are done 2 months after sowing and subsequent harvests at 30 days interval. Leaves and pods are dried for 7 - 10 days.

Yield

Irrigated

Dried leaves : 2 t/ha.

Dried pod : 150 - 200 kg/ha.

Rainfed

Dried leaves : 1 t/ha.

Dried pods : 75 - 100 kg/ha.

Seed Production Technology

Seeds attain physiological maturity at 40 days after anthesis associated with colour change of pods from green to brown. Seeds can be processed by using 8/64" round perforated metal sieves. Hard seededness can be effectively overcome by acid scarification with commercial sulphuric acid @ 100 ml/kg seed for 10 minutes.

Periwinkle

Catharanthus roseus

Apocynaceae

Varieties

White flowered, Purple flowered and Nirmal.

Soil and climate

It is suited to all types of soil and tropical climatic conditions. Well distributed annual rainfall of 100 cm or more is ideal for raising as a rainfed crop.

Seeds and planting

Propagated through seeds either by direct sowing or through transplanting.

Seed rate

2.5 kg/ha : Direct sowing

0.5 kg/ha : Through seedlings

45 - 60 days old seedlings are transplanted at a spacing of 45 x 20 cm during June - July or September - October.

Manuring

Basal

Apply FYM at 10 t/ha and N P and K at 50 kg/ha.

Top dressing

Apply 50 kg N 60 days after planting.

Aftercultivation

The crop requires 2 weedings, the first 90 days after sowing/transplanting and second 60 days after the first weeding.

Harvest

The crop becomes ready for harvest of roots after one year. Two leaf strippings can be taken, the first one after 6 months and the second after 9 months of sowing. Aerial parts are cut and the soil is ploughed for harvest of roots. Fruits are collected without damage.

Yield

	Irrigated	Rainfed
Roots	1500 kg/ha	750 kg/ha
Stems	1500 kg/ha	1000 kg/ha
Leaves	3000 kg/ha	2000 kg/ha

Seed Production Technology

The physiological maturity of periwinkle seeds is attained at 40 days of anthesis with maximum dry weight, germination and vigour with a change of pod colour from green to yellow with translucence.

Seeds can be processed by using 4/64" round perforated metal sieves with maximum seed recovery.

Pyrethrum

Chrysanthemum cinerariaefolium. Vis.

Asteraceae

Varieties

No named varieties.

Soil and climate

Light and medium well drained loamy soils are suitable. It grows best in areas, which have mild cool climate and a short winter and cool summer with an annual rainfall of 100 cm or more. A period of chilling in which the temperature falls below 17°C for six weeks is necessary for flower bud initiation.

Season

April - May and October - November.

Seeds and planting

Propagated by seeds with a seed rate of 2 - 3 kg/ha.

Seedlings are raised in nursery beds and transplanted after 6 - 8 weeks a spacing of 45 x 30 cm.

Manuring

Basal

Apply N, P and K at 20, 50 and 50 kg/ha.

Top dressing

20 kg of N in 2 split doses.

Harvest

Flowers are picked at fortnightly intervals from third month and dried immediately.

Yield

500 kg of flowers/ha.

Digitalis

Digitalis lanata Ehrh.

Scrophulariaceae

Varieties

No named varieties.

Soil and climate

A well drained sandy soil rich in organic matter and slightly acidic in reaction is suitable. It requires a cool and mild climate and comes up well in hill slopes.

Planting season

May - June.

Seeds and sowing

Propagated by seedlings.

Seed rate

8 kg/ha.

Spacing

45 x 30 cm.

Manuring

Basal

Apply FYM 10 t/ha, N and P at 30, 50 kg/ha respectively.

Top dressing

30 kg N as foliar application on 60th and 180th day after planting.

Aftercultivation

Give 1 - 2 weedings in the initial stages.

Harvest

8 - 10 cm long leaves (excluding petiole) are collected between July and August from the first year crop and second harvest taken one and half months later. Dry the leaves by passing hot wind at 60°C. 2 - 3 harvests can be done.

Yield

2000 - 3000 kg of dried leaves/ha.

Medicinal Dioscorea

Dioscorea floribunda Mart and Gal.

Dioscoriaceae

Varieties

Arka Upkar, Pusa 1 and PB(C) - 2.

Soil and climate

Well drained clay loam soil is suitable. Can be grown in tropical and sub-tropical climatic conditions.

Propagation

Propagated through single node leaf cuttings or tuber pieces.

Single node leaf cuttings

This consists of a single leaf with petiole and about 0.8 cm of the stem. The cuttings are quick dipped in 5000 ppm IBA and planted in mist chamber for rooting. After about 8 - 10 weeks, the plants are transferred to polythene bags. After 5 - 6 months, they are planted in the main field at a spacing of 45 x 30 cm during June - July or September - October. Rhizomes each piece weighing 50 - 60 g with one or two buds can also be used for planting. A pre-planting dip in Carbendazim 2 g/lit for 10 minutes is essential.

Manuring

Basal

Apply FYM 20 t/ha. N, P and K 100 kg/ha.

Top dressing

Apply 10 kg N in three equal splits at second, third and fourth months.

Aftercultivation

The vines need support for optimum growth and a pandal may be provided. Bamboo poles or gunny twines may be used to lead the vines to the pandal. 1 - 2 weedings are essential in the first year. Spray the crop with 25 ml Dicofol in 10 lit of water to control aphids and red spider mites.

Harvest

Harvest at 2 years of age manually using pick axes or deep ploughing with mould plough.

Yield

Fresh tubers	:	50 - 60 t/ha.
Diosgenin content	:	3.0 to 3.5 %

Medicinal solanum

Solanum khasianum Clarke.

Solanaceae

Varieties

RRL-20-2, RRL-SL-6, Glaxo, Arka Sanjivini.

Soil and climate

Well drained loamy soils are suitable. Grows well under moderate climatic conditions.

Seeds and planting

Being a hardy plant, even land with medium fertility can give a good stand. Propagated through seedlings.

Seed rate

400 g/ha. Requires a resting period of one month and sowing should not be delayed further. Seedlings are raised in nursery and transplanted at six leaf stage at a spacing of 50 x 50 cm during June - July. Drench the seedlings with Copper oxy chloride 2.5 gm/lit of water to prevent damping off disease in Nursery.

Irrigation

Irrigation should be given once in a week in the first month and later reduced to once in a fortnight.

Manuring

Basal

Apply FYM 10 t/ha. N, P and K at 25, 40 and 40 kg/ha respectively.

Top dressing

25 kg of N at second month after planting.

Aftercultivation

First weeding is done after 3 – 4 weeks, and second weeding at 2 – 3 months.

Harvest

After transplanting, the crop takes six months for harvest. The berries after harvest are dried.

Yield

Fresh berries	:	700 - 800 kg/ha
Solasodine content	:	2.0 to 2.5 %

Chapter B

Aromatic Plants

Lemongrass

Cymbopogon flexuosus

Graminae

Varieties

OD 19, Pragathi and Cauvery.

Soil and climate

Sandy loam with abundant organic matter and pH of 6.0. It comes up well under tropical and sub-tropical conditions with a high rainfall (200 - 250 cm) and humidity.

Seeds and planting

55,600 slips/ha at a spacing of 60 x 30 cm in ridges. Can also be propagated through seeds at 4 kg/ha. Seedlings are to be raised and transplanted during June - July.

Manuring

Apply FYM or compost at 20 - 25 t/ha as basal. Apply 50 kg N/ha annually, half at planting and half one month after planting. From the second year onwards, first dose of fertilizer should be applied after cutting and again one month after the first dose.

Irrigation

Life irrigation on third day and further irrigation at 7 - 15 days interval.

Aftercultivation

Hand hoeing and weeding as and when required.

Plant protection

Pests and diseases

In general, pests and diseases may not affect the plant. If there is any sucking pest spray Methyl demeton 25 EC or Dimethoate 30 EC 1 ml/lit. For caterpillars spray Phosalone 35 EC or Monocrotophos 36 EC 2 ml/lit.

Harvest

Harvest the leaves first at 90 days after planting and thereafter 75 - 90 days interval. Cut

the bush by leaving 10 - 15 cm above the ground level. Oil is extracted either by water or steam distillation method. Oil recovery 0.2 - 0.3 %.

Yield

Herbage	:	20 - 30 t/ha.
Oil		
First year	:	25 kg/ha.
Second year onwards	:	80 - 100 kg/ha.

Citronella

Cymbopogon winterianus

Graminae

Varieties

Java citronella, Java II and Ceylon citronella, B 10-13, Mandakini and Manjusha.

Soil and climate

Sandy loam with abundant organic matter and pH of 6.0. It comes up well under tropical and sub-tropical conditions with a high rainfall (200 - 250 cm) and humidity.

Season

June - July. 28,000 slips/ha at a spacing of 60 x 45 cm in ridges.

Manuring

Basal

FYM 30 t/ha and NPK at 25:40:40 kg/ha.

Top dressing

75 kg N/ha in 3 equal splits of 25 kg each at 3, 6 and 9 months after planting.

Irrigation

Life irrigation on third day and again at 10 – 15 days interval.

Aftercultivation

1 - 2 weedings at the initial stages and earthing up after each harvest.

Plant protection

Diseases

Leaf blight

Spray any one of the Dithiocarbamates namely Mancozeb or Zineb at an interval of 15 - 20 days.

Harvest

The first harvest at 6 months after planting. Second and subsequent harvest at two and a half months intervals.

Yield

Herbage : 20 - 30 t/ha/year.

Oil is extracted by water distillation. Oil content 0.2% to 0.3%.

OIL

First year : 50 - 100 kg/ha.

Second year : 100 - 150 kg/ha.

Fifth year : 250 - 300 kg/ha.

Geranium

Pelargonium graveolens (L) Hervitt.

Geraniaceae

Varieties

Kodaikanal 1.

Soil and climate

A deep light porous well drained soil rich in organic matter and acidic in reaction with a pH 5.5 to 6.0 is suitable. An elevation ranging from 1000 - 2400 m with an annual rainfall of 100 to 150 cm evenly distributed throughout the year is ideal.

Propagation

Geranium is propagated by stem cuttings. Cuttings of about 10 cm taken from current season growth with a well formed crown of leaves with 3 - 4 nodes and terminal bud and raised on sphagnum moss or in polythene bags of 10 x 10 cm size. Thorough field preparation leading to fine tilth condition is essential. Pits of 30 x 30 cm size are dug and cattle manure at 250 g/pit is applied and rooted cuttings of 2 months age are planted at a spacing of 45 x 45 cm during April - May.

Manuring

60 kg in each of N, P and K/ha is recommended. P and K are applied every year at the time of first harvest while N is applied in equal splits depending upon the number of harvests per year.

Irrigation

Geranium is usually grown as a rainfed crop. Irrigation during dry periods increases the yield.

Aftercultivation

Weedings, uprooting and burning the diseased plants throughout the life cycle of the plant. From the second year onwards give a deep soil forking around the plants to improve the growth of more suckers.

Pruning

Pruning of the bushes is necessary when the bush shows signs of decline. The branches are cut back leaving 15 - 20 cm once in 4 - 5 years.

Plant protection

Pests

Nematode

To control the nematodes (*Meloidogyne hapla*) in nursery, apply Carbofuran at 2 kg a.i./ha once in 6 months in June and December.

Diseases

Wilt

Drench with Quintozene 1 g/lit at monthly intervals.

Harvest and distillation

In the year of planting only one harvest can be done at 7 - 8 months and thereafter 3 or 4 harvests can be done in a year. The tender tip portion with 6 - 12 nodes constitute the materials for harvest. The harvested material is withered in shade for two to three hours and distilled.

Yield

Herbage	:	20 - 25 t/ha.
Oil yield	:	15 - 20 kg/ha.

Palmarosa

Cymbopogon martinii var. motia (Roxv) Wats.

Graminae

Varieties

Trishna and PRC-1.

Soil and climate

A well drained loamy soil is suitable. Comes up well under tropical conditions with an annual rainfall of about 150 cm.

Seeds and planting

Through seeds

2.5 kg of seeds/ha.

Sow in raised nursery beds in lines 15 - 20 cm apart. Transplant at 3 - 4 weeks in ridges at a spacing of 60 x 60 cm during June - July.

Through slips

Establishment will be poor as compared to seedlings.

28,000 slips/ha will be required to plant at 60 x 60 cm spacing.

Manuring

Basal

FYM 10 t/ha and NPK at 20:50:40 kg/ha.

Top dressing

15 kg/ha in 3 splits at 3, 6 and 9 months of planting.

Aftercultivation

Give 1 - 2 weedings in the early stages and earth up after each harvest and top dressing.

Harvest

The first harvest commences at 3 - 4 months of planting. Subsequent harvests at 3 - 4 months interval.

Yield

Herbage	20 - 30 t/ha/year.
Oil	
First year	20 kg/ha.
Second year	60 kg/ha.
Third and Fourth year	70 kg/ha.

Seed Technology

Seeds attain physiological maturity at 40th day after 50% flowering when the fluff (seed) moisture is around 20%. Leaching of fluffs in running water for 8 hours followed by soaking in KNO_3 at 0.5% for 6 hours recorded maximum germination.

Patchouli

Pogostemon patchouli Hook.

Labiatae

Varieties

Johori, Java, and Malaysian types.

Soil and climate

Well drained loamy soil with slightly acidic condition is suitable. Thrives best in hot and humid conditions, under shade of rubber, coconut, coffee, etc.

Propagation and Planting:

Rooted stem cutting of 15-20 cm are used. The field is prepared to a fine tilth and the rooted cuttings are planted at a spacing of 60 x 30 cm during April – May.

Manuring

Basal

Apply NPK at 30 kg/ha each.

Top dressing

30 kg N/ha after 3 months of planting.

Irrigation

Grown as a rainfed crop in hills. In plains irrigation is to be given at 7 - 10 days interval.

Plant and protection

Pests

Nematode

Application of Carbofuran 3g in the nursery (10g a.i./100m^2).

Harvest

First harvest when fully grown (6 - 8 months). Subsequent harvest at 3 to 5 months intervals. The leaves are dried in shade and distilled.

Yield

30 - 40 kg oil/ha/year.

Mint

Mentha sp

Labiatae

Varieties

No named varieties.

Soil and climate

Well drained loamy and acidic soil high in organic matter content is suitable. Sub-tropical areas reeeiving an annual rainfall of 100 - 150 cm are good.

Propagation and planting

Rooted stem cuttings are planted in beds at 40 x 40 cm spacing during June - July.

Manuring

Basal

Apply NPK at 30, 60 and 10 kg/ha.

Top dressing

Apply 30 kg N in 2 splits at 60th and 120th day of planting.

Harvest

First cutting starts in about 5 months after planting and subsequently at 3 months interval. Under good management conditions, the crop will give economic yield for about four years.

Yield

Herbage	15 - 20 t/ha/year.
Oil	50 - 100 kg/ha/year.

Part VI

Commercial flowers

Rose

Rosa sp

Rosaceae

Varieties

Edward Rose and Andra Red Rose.

Soil and climate

Well-drained sandy loam is suitable. Can be grown in the plains of Tamil Nadu.

Propagation and planting

Layers and rooted cuttings. Pits of 45 cm x 45 cm x 45 cm are dug at 2.0 x 1.0 m spacing and 10 kg FYM is added to each pit before planting. Lindane 1.3% 20 g per pit is added to prevent attack by white ants.

Irrigation

Once in 2 days until plants establish and once a week thereafter.

Manuring

After pruning in October and again in July the plants are manured with FYM 10 kg and 6:12:12 g of NPK per plant.

Aftercultivation

Pruning is done during the second fortnight of October by cutting back the vigorous past season shoots to half the length. All the weak, diseased, criss-crossing and unproductive shoots are removed. The cut ends should be protected with Bordeaux or Fytolan paste + Carbaryl 50 WP.

Plant protection

Pests

Rose chaffer beetle

1. Hand picking Cetonid beetles and destroy during day. Spray Endosulfan 35 EC 2 ml/lit.

2. Setup light to attract *Holotrichia* and *Anomala* spp.

Red scale

Rub off the scales with cotton soaked in Kerosene or Diesel. Cut and burn the affected branches. Spray Malathion 50 EC 2 ml/lit at the time of pruning and again during March – April or Apply Carbofuran 3G 5 g/plant or spray Fish oil resin soap 25 g/lit or Endosulfan 30 EC 2 ml/lit.

Mealy bug

Spray Monocrotophos 2 ml/lit or Methyl parathion 2 ml/lit.

Flower caterpillar

Helicoverpa armigera

Spray Ha NPV 1.5 x 10^2 PIB/ha.

Spodoptera litura

Spray Sl NPV 1.5 x 10^2 PIB/ha.

Bud worm

Spray Monocrotophos 36 WSC 2 ml/lit at fortnightly interval during flowering.

Thrips, aphids and leaf hoppers

Spray Methyl-o-demeton 25 EC 2 ml/lit of water or Carbofuran 3G 5 g/plant. Spray Neem oil 3 % or Phosalone 35 EC 2 ml/lit.

Diseases

Black spot disease (*Diplocarpon rosae*)

Spray Carbendazim 1 g/lit twice at fortnightly intervals.

Powdery mildew

Spray Carbendazim 1 g/lit or Wettable sulphur at 2 g/lit.

Crop duration

The plants will start flowering in the first year and will give economic yield from the second year onwards.

Season of flowering and harvesting

Flowering will commence 45 days after pruning. Fully opened flowers are picked early in the morning.

Yield

About 10 lakh flowers/ha/year.

Hybrid Rose

Rosa hybrida

Rosaceae

Varieties

YCD 1, YCD 2, YCD 3, other Hybrid Teas and Floribundas.

Soil and climate

Generally suitable for higher elevation (1500 m and above). Can also be grown in the plains under ideal condition of fertile loamy soils with salt-free irrigation water.

Propagation and planting

Propagated by rooted cuttings or by budding on Briar root stocks in hills and on Edward Rose and *Rosa indica* in plains. One year old budded plants are planted in July - August at 75 cm x 75 cm spacing.

Aftercultivation

The plants should be watered daily until they establish and thereafter once in a week. Pruning is done during March and October. Spray Diuran 2.5 kg a.i/ha to control weeds. Avoid spray fluid coming in contact with Rose plants.

Manuring

At three months interval apply FYM at 10 kg and 8:8:16 g NPK per plant after each pruning. For cv. Happiness NPK may be applied at 75:150:50 g/plant per year.

Yield

70 - 80 for Hybrid Tea Roses per plant per year.

80 - 90 for Floribundas per plant per year.

Malligai

Jasminum sambac Ait.

Oleaceae

Varieties

Gundumalli.

Soil and climate

Well drained fertile soil.

Preparation and planting

Layers or rooted cuttings are planted with a spacing of 1.25 m either way to accommodate 6400 plants per ha during June to November in pits 30 x 30 x 30 cm. 20 kg FYM per pit is applied before planting.

Irrigation

Irrigation should be given immediately after planting followed by weekly irrigation depending upon weather conditions.

Manuring

FYM 10 kg and NPK at 60:120:120 g per plant applied twice once after pruning and again during June - July.

Pruning

The bushes are pruned to 50 cm height from the ground level during last week of November.

Plant protection

Pests

Bud worm

Spray Monocrotophos 36 WSC 2 ml/lit.

Blossom midge

Spray Monocrotophos 36 WSC 2 ml/lit or Endosulfan 35 EC 2 ml/lit.

Red spider mite

Spray Sulphur 50 % WP 2 g/lit or Dicofol 18 EC 2.5 ml/lit.

Diseases

Yellowing of leaves

It is caused by 3 factors viz., iron deficiency, nematode infection and root rot disease.

Iron deficiency

Spray Ferrous sulphate 5 g/lit at monthly intervals until the chlorotic symptoms disappear.

Nematode

Test the soil for nematode infection. Apply 10 g of Temik granules near root zone and irrigate.

Root rot

Drench the soil around the plant with Copper oxychloride at 2.5 g/lit.

Season of flowering and harvest

Flowering commences in March - April. Fully developed unopened flower buds should be picked in the mornings.

Yield

8750 kg of flower buds/ha.

Mullai

Jasminum auriculatum (Vahle.)

Oleaceae

Varieties

Co 1 and Co 2.

Soil and climate

Well drained red and sandy loam soils under tropical conditions are suitable.

Season of planting

June to November.

Propagation and planting

Layers or rooted cuttings are planted in 30 cm x 30 cm x 30 cm pits dug at 1.5 x 1.5 m spacing to accommodate 4400 plants per ha.

Manuring

FYM 10 kg/ha. 120:240:120 g NPK/plant applied in six split doses at bimonthly intervals, the first dose being given immediately after pruning.

Pruning

The bushes are pruned to 45 cm height from ground level during the last week of January.

Plant protection

Pests

Bud worm

Spray Monocrotophos 36 WSC 2 ml/lit.

Red spider mites

Spray Sulphur WP 2 g/lit.

Leaf eating caterpillar

Spray Endosulfan 35 EC 2 ml/lit.

Season of flowering and harvest

May to November. Fully developed unopened flower buds should be picked in the morning.

Yield

10,000 kg of flower buds/ha.

Jathi malli (Pitchi)

Jasminum grandiflorum L.

Oleaceae

Varieties

Co 1 and Co 2.

Soil and climate

Well drained red loamy soils and tropical climate are best suited.

Season of planting

June - November.

Propagation and planting

Layers or rooted cuttings are planted at 2.0 x 1.5 m spacing (3350 plants/ha) in 30 cm x 30 cm x 30 cm pits.

Irrigation

Once in 10 days.

Manuring

FYM or compost 10 kg, NPK at 60, 120 and 120 g per plant applied in 2 split doses in December after pruning and again in June - July.

Pruning

Pruning is done during the last week of December to 45 cm height from ground level.

Plant protection

Pests

Bud worm

Spray Monocrotophos 2 ml/lit.

Holotrichia beetle

Install light trap to attract the adults immediately after summer rain.

Incorporate Lindane 1.3 % into the soil 25 g/bush.

Red spider mite

Spray 50 % Wettable sulphur 2 g/lit.

White ants

Dust Lindane 1.3 % to the pits before planting at 5 g/pit.

Diseases

Leaf spot

Spraying of Mancozeb at 2 g/lit. from the onset of monsoon at monthly intervals.

Season of flowering and harvest

May to October. Fully developed unopened flower buds are picked in the morning for fresh flower trade. For oil extraction open flowers are to be picked before 10 a.m.

Yield

11 t/ha of flower buds.

Jasmine concretes 29 kg/ha.

Crossandra

Crossandra infundibuliformis L.

Acanthaceae

Varieties

Orange, Red and Delhi Crossandra.

Soil

Well drained sandy loam soil.

Seeds and sowing

Fresh seeds are sown during July - October in raised beds 15 cm apart in lines. Watering should be done daily. The seedlings will be ready for transplanting in 60 days.

Seed rate

5 kg/ha for plant population.

For Delhi Crossandra, rooted cuttings have to be used for planting.

Preparation of field

Land is ploughed thrice and FYM at 25 t/ha is incorporated. Ridges are formed 60 cm apart. Dip the roots of seedlings in Emisan (1 g/lit of water) and plant on one side of the ridge at 30 cm spacing. For seed production the spacing may be 60 x 60 cm. For Delhi Crossandra a spacing of 60 x 40 cm is to be followed.

Aftercultivation

Spray Diuron (pre-emergence) 2.5 kg a.i/ha for weed control.

Manuring

Apply FYM 25 t/ha as basal and NPK at 75, 50 and 125 kg/ha as top dressing three months after planting. Repeat NPK application at the same dose at half yearly intervals for two more years. Instead apply N at 60 kg/ha + *Azospirillum* 2 kg/ha and three months after planting spray ascorbic acid 1000 ppm for high yield (1 g/lit of water).

For Delhi Crossandra

Basal

Apply FYM 25 t/ha, Gypsum 100 kg/ha and P & K at 50 and 100 kg/ha.

Top Dressing

30 days after planting, apply Neem cake 250 kg and N 40 kg/ha. Apply 90 days after planting N P K 40:20:60 Kg and repeat this dose at quarterly intervals for a time period of two years.

Irrigation

Once in a week.

Plant protection

Pests

Nematode

Avoid planting Crossandra in nematode infested fields. To control nematodes application of Phorate or Carbofuran 3 G at 1 kg a.i./ha a week after planting and to be repeated six months after application with any one of the above chemicals at 3 and 9 gm respectively per metre length.

Aphids

Spray Dimethoate 30 EC 2 ml/lit.

Diseases

Wilt

Drench the soil around the plants with Methoxyethyl mercury chloride (Emisan) at 2 g/lit or Carbendazim 0.5 ml/lit.

Crop duration

3 years including ratoon crop in the third year.

Harvest

Flowering will start a month after transplanting. Fully opened flowers are picked once in two days.

Yield

2000 kg of flowers per ha/year.

Delhi Crossandra 2800 kg of flowers per ha per year.

Chrysanthemum

Dendranthema grandiflora. Tzeuleu

Asteraceae

Varieties

Co 1, Co 2 and MDU 1.

Soil

Well drained red loamy soils.

Propagation and planting

1,11,000 suckers obtained from 15 cents of the previous crop are required to plant 1 ha. Dip the roots of the suckers in Emisan 1 g in 1lit to protect against wilt. The suckers are planted during June - July at 30 x 30 cm spacing on one side of the ridges. Pinching once in 4 weeks after planting to induce more branching.

Irrigation

Twice a week in the first month and subsequently at weekly intervals.

Manuring

FYM 25 t/ha + 125:120:25 kg NPK/ha, half of the N and the entire dose of P and K are to be applied basal just before planting. The other half of N is to be applied 30 days after planting the suckers. The same dose has to be repeated if a ratoon crop is allowed in December. Spray GA at 50 ppm 30, 45 and 60 days after planting to increase the flower yield.

Plant protection

Pests

Thrips, Aphids and leaf eating caterpillars

Spray Monocrotophos 36 WSC 2 ml/lit.

Diseases

Root rot

Drench the soil around the plants with Copper oxychloride 2.5 g/lit.

Leaf spot

Spray Mancozeb 2 g/lit.

Duration

6 - 8 months for plant crop and 4 months for ratoon crops.

Harvest

Pick the flowers from 3rd month onwards at 4 days intervals.

Yield

20 t/ha from plant crop.

10 t/ha from ratoon crop.

Marigold (African marigold)

Tagetes erecta L.

Asteraceae

Varieties

MDU 1, Orange and Yellow.

Soil

Well drained loamy soil.

Seeds and sowing

Sown throughout the year. Nursery is raised with 1.5 kg seed/ha and the seedlings are transplanted after four weeks on one side of the ridge at 45 x 35 cm spacing. Treat the seeds with *Azospirillum* (200 g in 50 ml of rice gruel) before sowing.

Irrigation

Once in a week or as and when necessary. Water stagnation should be avoided.

Manuring

Apply 45:90:75 kg NPK/ha as basal and 45 kg N/ha as top dressing 45 days after planting.

Crop duration

130 - 150 days.

Harvest

Flowers are picked once in 3 days beginning from 60 days after planting.

Yield

18 t/ha.

Tuberose

Polianthes tuberosa L.

Amaryllidaceae

Varieties

Single flowered varieties of Mexico, Poona, Calcutta, Bangalore, Shringar and Suvasini. Mexican single is preferable.

Soil

Well drained loamy soil.

Propagation and planting

Corms (25 to 30 g) are planted (1,12,000 corms/ha) on the sides of ridges at 45 x 20 cm spacing at 2.5 cm depth during June - July. Corms are planted after 30 days of harvest. Dip the corms in 5000 ppm CCC (5 g/lit) before planting to increase the yield.

Manuring and Aftercultivation

FYM 25 t/ha. NPK 100:60:60 kg/ha. After 2 months 25 kg N is applied. Thereafter 25 kg of N is given every 3 months. 25 kg N and entire P and K are applied as basal.

Plant protection

Pests

Nematode

Apply Carbofuran 3 G 1 g/plant near the root zone and irrigate immediately.

Crop duration

2 years. The crop can be maintained for one more year with good management practices.

Harvest

Flowers are picked daily.

Yield

6000 kg of flowers/ha/year.

8 to 10 kg concrete per ha.

Nerium

Nerium indicum Mill.

Apocynaceae

Varieties

Single Rose, Single White, Single Red and Double Types.

Soil

Red lateritic or black or loamy soils with adequate drainage.

Propagation and planting

Hard or semi hard woodcuttings of 60 cm length are used; their ends are buried inside the soil forming an arch. Rooted cuttings can also be planted in the normal manner during June to July in 30 cm x 30 cm x 30 cm pits dug at 2 m x 2 m spacing and filled with FYM, red earth and top soil.

Aftercultivation

The plants are irrigated as and when required and manured with 10 t FYM/ha during January and again in August. No chemical fertilizers are normally applied.

Plant protection

Pests and diseases

No serious pests or diseases affect this crop.

Leaf Caterpillar

Spray Endosulfan 35 EC 1 ml/lit or Phosalone 35 EC 1 ml/lit or Monocrotophos 2 ml/lit.

Flowering season

Throughout the year.

Peak flowering between April to August.

Harvest

Flowering begins from the 4th month after planting.

Yield

100 - 125 kg of flowers/ha/day.

Marikolundu (Dhavanam)

Artemisia pallens Walls.

Asteraceae

Varieties

Local.

Soil and climate

A well-drained loamy soil with irrigation facilities preferably under cooler climate is suitable.

Seeds and sowing

During November 1.5 kg of seeds per ha is sown in raised bed and seedlings are transplanted after 30 days at 15 x 7.5 cm spacing in beds.

Aftercultivation and manuring

Crop is irrigated in four or five days. Apply NPK at 125:125:75 kg/ha with 25 t FYM and

P and K as basal and 125 kg N/ha as top dressing with 50 kg N as first dose on 25th day of transplanting followed by 25 kg N every time after 75, 110 and 150 days of transplanting (after every cuttings)

Crop duration

5 - 6 months.

Harvest

The plants become ready for cuttings in two and half months after transplanting. Subsequent cuttings are taken at 30 - 40 days intervals.

Oil recovery will be 0.13 % on 50th day and 0.23 % on the 75th day.

Maruvu

Origanum majorana L.

Labiatae

Varieties

Local.

Soil and climate

Well drained loamy soils.

Propagation and planting

Cuttings from the previous crop are planted during December - January on both the sides of the ridges at 30 x 15 cm spacing.

Irrigation

Once in 4 or 5 days.

Manuring

Basal

FYM 25 t/ha. and NPK 55:110:60 kg/ha.

Top dressing

After first cutting 55 kg N/ha.

Plant protection

Pests

Aphids

Spray Dimethoate 30 EC or Methyl-o-demeton 25 EC at 2 ml/lit.

Duration

2 years.

Harvest

The herbage becomes ready for harvest in 100 days and thereafter once in every 30 to 40 days.

Yield

10,000 kg of herbage/year/ha.

Carnation

Dianthus Spp

Coryophyllaceae

Varieties

Standard type - Rani, Prandilo, Raizo, Zohar, Weloge, Isac, Orange Isac etc.

Spray type - White Moon, White Diamond, White Pearl, Rani etc.

Soil and Climate

Well drained and Red loamy soil with the pH of 6 is most suitable. Temperature should be within the range of 25°C - 27°C.

Season

Throughout the year as it is cultivated under controlled conditions.

Propagation and Planting

Plantlets/suckers. Raised beds at 3 feet width and 45 cm height are formed at 45 cm interval and planting is done on top of the bed at 15 x 15 cm spacing.

Irrigation

Irrigation is provided with drip system once in 2-3 days according to soil moisture to

maintain water holding capacity at 60% to 65%.

Manuring

Basal : Neem cake 2.5 ton/ha. Phosphorus 400 g/100 sq.feet, Magnesium sulphate 0.5 kg/100 sq.feet.

Top dressing

Calcium Ammonium Nitrate + MOP at 5:3 ratio is mixed and applied @ 2.5 g/plant/month.

Plant Protection

1. Nematode - Carbofuran 20 g/sq.m.
2. Leaf spot - Carbendazim 2 g/lit.
3. Blight - Spray Carbendazim 2 g/lit or Mancozeb 2 g/lit.
4. Wilt - Drench Carbendazim or Mancozeb at 2 g/lit.
5. Root rot - Drench Carbendazim or Mancozeb at 2 g/lit.

Season of Flowering development and Harvest

Starts after 4 months of planting and continued upto one and half years. Daily harvest is made leaving bottom 5 nodes of stalk to facilitate side shoot development. To keep the stalk erect 4 – 5 stage stocking is provided.

Post harvest Treatment

Citric acid is added to water to make the pH 4.5 to 5 and 5 mg of Sodium hypochloride is added to 1 litre of water. Cut flower stalk is soaked in this solution for 4 – 5 hours to improve vase life.

Grading

Based on Stem thickness, stem length and quality of flower grading is done as A, B, C,D

Yield

8 Stalks/plant/year.

Gladiolus

Gladiolus spp

Varieties

White Prosperity, Novalux, Pricillia, Hunting Song, Trades Horn, Wind Song, Peter Pears etc.

Soil and Climate

Well drained soil with the pH of 6 is highly suitable. Temperature should range between 27°C and 30°C.

Season

This crop requires minimum 10 hours of sunlight to over come blindness. So season should be adjusted or light substitution is given.

Propagation and planting

Corms conforming the grades (height/circumference) 8/10, 12/14, 10/12

Bed system	:	15 cm x 15 cm
Ridges and furrows	:	60 cm x 15 cm in zigzag manner.

Irrigation

Open field 7-8 days interval. Poly house - Drip irrigation 2-3 days interval.

Manuring

Basal	N	60 kg/ha.
	P	150 kg/ha
	K	150 kg/ha

Top dressing N alone is given.

30 kg/ha - 4 leaf stage as foliar spray.

30 kg/ha - Bud stage as soil application.

After cultivation

Hand weeding is done whenever necessary.

Plant Protection

Corms are dipped in hot water at 40 - 45oC + Fungicide (Captan or Thiram 2 g/lit) to control Nematode and fungal disease.

Thrips – Methyl-o-demeton 25 EC 2 ml/lit. or Dimethoate 30 EC @ 2 ml/lit.

Semilooper and *Helicoverpa* – Methyl-o-demoton or Monocrotophos @ 2 ml/lit.

Leaf spot

Spray Carbendazim or Mancozeb 2 g/lit.

Season of flowering and Harvesting

When first bud shows the colour of the variety harvesting is started

Early varieties	-	75th day
Mid season varieties	-	80th day
Late season varieties	-	85-90th day

Post harvest treatment and Grading

Soaking stem in water to avoid wilting and lodging of stem and flower. Based on stem length and number of florets grouped into A, B, C, D grades.

Yield

Only 85% of stalks produced will give flowers and remaining 15% will become blind, so 2.0 to 2.5 lakhs stalks/ha can be harvested per crop.

Gerbera

Gerbera jamesonii

Compositae

Varieties

Ventury, Fiana, Gold spot, Yellow River, Sunny boy, Testrosa, Nivetha, etc.

Soil and Climate

Sandy loam with well drainage with the pH of 5.5 - 6 is well suitable. Temperature should be within the range of 25° C - 27° C to avoid bud abortion/searching. So crop is raised under polygreen house.

Season

Throughout the year.

Propagation and Planting

Suckers Tissue culture plantlets. Raised beds with 4 ft. width and 40 cm height are formed at an interval of 60 cm and planting is done at a spacing of 30 x 30 cm.

Irrigation

Provided with drippers once in 2 – 3 days of 3.75 litre/drip/lit for 15 – 20 minutes. Average requirement is 500 – 700 ml/day/plant.

Manuring

Basal	Neem cake 2.5 ton/ha
	P - 400 g/100 sq.ft.
	$MgSo_4$ - 0.5 kg/100 sq.ft.

Top dressing

Calcium Ammonium Nitrate and Muriate of Potash at the ratio of 5:3 is mixed and applied at 2.5 g/plant/month.

After cultivation

Hand weeding is done whenever necessary.

Plant Protection

1. To control Nematode - Carbofuran 7-8 kg/ha is applied at the time of planting.
2. Leaf spot - Carbendazim 2 g/lit or Mancozeb 2 g/lit is sprayed alternatively.
3. Leaf miner - Chlorpyriphos 20 EC 2 ml/lit.
4. Greenhouse whitefly - Monocrotophos 36 WSC 2 ml/lit or Neem oil 3 ml/lit.

Season of flowering and Harvesting

When flowers completely open harvesting is done, flower stalk is soaked in Sodium hypochloride solution (5-7 ml/lit of water) for 4-5 hours to improve vase life.

Grading

Based on stem length and diameter, flowers are graded in A, B, C and D.

Yield

2 stems/plant/month. Harvest starts from 3rd month of planting and continued upto two years.

Golden rod

Salidago spp

Asteraceae

Varieties

Local.

Soil and climate

Sandy loam and Red loam soils with proper drainage grown under varied climatic condition, cooler climate gives high quality cut flower.

Season

Throughout the year.

Propagation and Planting

Suckers. Soil ploughed to fine filth, flat beds are formed slips are planted at 45 x 45 cm spacing.

Irrigation

Normally once in three days to keep the soil always wet to induce profuse stalk production.

Manuring

N P K at the rate of 140 : 175 : 150 kg/ha. + 5 t FYM/ha as basal and half the dose is applied after every harvest.

After cultivation

Hand weeding as and when required.

Plant protection

No serious pests and diseases occur during crop growth.

Season of flowering and Harvesting

First harvest is made after 75th day of planting and continued daily for 30 days. This practice is repeated continuously for 2 years.

Yield

3 lakhs stems/crop/ha.

Aster

Aster amellus

Asteraceae

Varieties

Red, White, Orange and Pink. All colours are available in light and dark shades.

Soil and climate

Well drained red loamy and sandy loam soils. This crop comes up well in cooler climates.

Season

Throughout the year.

Propagation

Seeds 10-12 kg/ha.

Land preparation and sowing

Soil made into fine filth and flat beds are formed. Seeds are sown either by broad casting or line sowing at 20 x 15 cm.

Irrigation

Irrigate once in 4-7 days according to soil moisture conditions.

Manuring

5 t FYM/ha + NPK 70 : 175 : 75 kg/ha as basal.

Weeding

Two hand weedings.

Plant protection

1) Spray Methyl-o-demeton 2 ml/lit to control sucking pests.

2) To control leaf spot, Carbendazim @ 2 g/lit.

Harvest

Starts 110 days and staggered upto 140 days.

Yield

0.9 lakhs to 1.0 lakhs stem per/ha.

Particulars of Improved Varieties of Horticultural Crops

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
A. Fruits				
Mango	PKM.1	Perennial	500 fruits/tree (100 kg/tree)	A high yielder selected from a hybrid (Chinnaswarnareka x Neelum). Regular bearer, fruit is big and sweet in taste.
	Paiyur.1	Perennial	8.92 t/ha	Dwarf tree, suitable for close planting (400 trees/ha); regular bearer; medium long fruits, oval yellow skin and good taste and keeping quality.
Banana	Co.1	13 – 14 months	22 t/ha	It is a multiple cross involving Ladan (AAB) as female parent and *Musa bulbisiana* (BB) and Kadali (AA) as male parents. It is akin to hill banana Virupakshi; retains the flavour and taste of Virupakshi and suited to plains.
Sapota	PKM.1	Perennial	236 kg/tree (3500 fruits/tree)	Clonal selection from Guthi; dwarf statured and adaptable to southern and central districts.
	Co.1	Perennial	12 – 20 kg/tree	It is a hybrid between Cricket ball and Oval; small size with sweet taste
	Co.2	Perennial	16 – 25 kg/tree	It is a pure line selection from Baramasi; round shape; bigger than Co.1
	PKM.2	Perennial	80 kg/tree	Hybrid between Guthi and Kirtibarthi. Fruits are bigger in size, oval shaped. Higher TSS.
	PKM.3	Perennial	14 t/ha	Hybrid between Guthi and Cricket ball. Suitable for high density planting. Tolerant to leaf spot and leaf webber.
Papaya	Co.1	2.5 years	200 t/ha/ 2 years	It is a selection from Ranchi. A choice round fruit, dwarf type suited exclusively for table purpose with yellow flesh and good quality.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	Co.2	2.5 years	200 t/ha/2 years Papain 500kg/ ha/2years	A pure line selection suitable for papain as well as table purpose; medium tall variety large sized fruit with yellow flesh.
	Co.3	2.5 years	120 – 150 t/ha/2 years	It involves the parents Co.2 and Sunrise Solo. It is a hermaphrodite type with red flesh and sweet taste exclusively suitable for table purpose. It is a medium tall variety with small sized fruits.
	Co.4	2.5 years	200 t/ha/2 years	It is a hybrid derivative from a cross between Co.1 x Washington. It has purple pigmentation on the stem, petiole, flower stalk etc. Fruits are round with purple tinged yellow flesh. Tree medium tall, suitable for home and kitchen gardens; a table purpose variety.
	Co.5	2.5 years	Papain 1200 kg/ha/2 year	It is a pure line selection from Washington variety, medium tall with purple pigmentation all over the plant surface; fruits are large, weighs 2 to 2.5 kg/fruit. It gives the highest papain yield of 15 g/fruit. Exclusively suitable for papain extraction only. Not recommended for table use.
	Co.6	2 years	80 – 100 fruits/year	Selection from a giant papaya. Dioecious. Suitable for papain extraction and also for table purposes. Dwarf in stature.
	Co.7	2 years	340 t/ha	Gynodioecious. Parents involved are Pusa Delicious, Co.3, CP 75 and Coorg Honeydew. Red fleshed. Fruits oblong with an attractive and firm red flesh.
Pomegranate	Co.1	Perennial	50 fruits/bush	It is a pure line selection. It is quick growing, high yielding and with attractive fruit colour both exterior and interior. It has soft seeds, with sweet taste and bright pink colour.
	YCD.1	Perennial	60 – 70 fruits/bush	Soft – seeded; clonal selection from local varieties. 20% more than the local. The colour of the pulp is purple. Keeps well for about 5 – 7 days at cold temperature.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
Jack	Palur.1	Perennial	80 fruits/tree/ year weighing 900 kg	Clonal selection from Panikkan kuppan local. Suitable for high density planting. Yield fruits in off season also (Nov – Dec). Regular bearing season April – June.
	PPI.1	Perennial	107 fruits/ tree/year	weighing 1018 kg Clonal selection from Millagumoodu local. Suitable for commercial planting and in Home gardens.
Apple	KKI.1	Perennial	22 t/ha	Selection from Parlin's Beauty. Best adapted to warm winter conditions prevailing in Kodaikanal hills.
Amla	BSR.1	Perennial	155 kg fruits/ tree/year	Selection from Thimbam local type. Fruits contain more flesh, less phenol and high ascarbic acid content.
Avocado	TKD.1	Perennial	26.4 t/ha	Suitable for high density planting. Fruits are dark green coloured, round shaped and medium in size.
Fig	Yercaud Timla	Perennial	4000 Nos. per tree per year	It is drought tolerant, high yield, fruits are large and reddish purple in colour.
B. Vegetables			**t/ha**	
Tomato	Co.1	135	36	Round fruits, light green when unripe and red at ripening, bears in clusters.
	Co.2	145	42	Fruits ovate, large and flat.
	Co.3	110	50	Dwarf plants fruits globular and red; bears in clusters of 4 - 5 fruits. Suitable for summer.
	PKM.1	135	32	Determinate plants; fruits flattish with ridges. Suited for long distance transport.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	Paiyur.1	130	32	A hybrid derivative suitable for irrigated and rainfed conditions of Dharmapuri district. Fruits are round, smooth fleshy and suitable for long distance transport.
	COTH.1	110 – 115	95.9	F1 hybrid developed by crossing IHR 709 x LE 812. Plants are semi determinate. Fruits are medium sized, bright redd, smooth, round to slightly oblong and born in clusters of 4 – 5.
Brinjal	Co.1	100	24	Fruits light green with white - base and oblong. Medium sized fruits (50-60g); good keeping quality.
	MDU.1	135	34	Fruits round, bright purple and weight 280 g.
	PKM.1	150	34	Fruits are medium sized, 45 - 65g; drought tolerant and can withstand long distance transport.
	Co.2	150	35	Fruits are oblong with brown stripes. Suitable for Periyar and Coimbatore districts.
	KKM.1	130 – 135	37	Fruits egg shaped with milkywhite colour born in clusters of 2 – 4.
Bhendi	Co.1	90	14	Plants medium tall; pods pink, long tender and less fibrous; tolerant to yellow vein mosaic.
	Co.2	90	16.51	Fruits fairly long with hairy surface.
	Co.3	90	16 – 18	Fruits medium in size and dark green in colour. Moderately resistant to yellow vein mosaic disease.
Chillies	Co.1	210	2.1	Fruits long and red at ripening; seed content 55%; samba type.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	Co.2	210	2.2	Fruits oblong and bright red on ripening; seed content 60%
	K1	210	1.8	Plants bushy; pods green; long samba type; dark red on ripening.
	K2	210	1.98	Plants tall, compact, pods long and bright red on ripening; samba type; high seeded content.
	PKM.1	200	2.36	Suitable for semi-dry condition. Fruits contain high Capsaicin content - 0.36%
	MDU.1	215	1.8	Determinte growth. Fruits born in clusters of 4 – 9. Fruits are long with dark shiny red colour.
	Co.3	165	3 – 3.5	Fruits long, slender with attractive dark green colour. Suitable for export purposes.
	PLR.1	210	18.4 t of green chillies/ha	Suitable for green chillies.
Pumpkin	Co.1	175	30	Fruits are globular, large sized (8 – 10 kg); light pink skin and yellow flesh.
	Co.2	135	23	Fruits small (1.5 kg), flattish round, light brown skin and yellow flesh
Snakegourd	Co.1	135	16	Fruits long (160 - 180 cm) green with white stripes, each weighs 500 - 750 g, smooth flesh of less fibre; moderately resistant to powdery mildew.
	PKM.1	145	26	Fruits dark green with white stripes; each weighs 700 g; suitable for growing all through the year.
	MDU.1	125	32	Vines less spreading with moderate branching; flowers in 56 days; fruits are short (40 cm) and weighs 550 g.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	Co.2	105	36	Fruits are short ant stout weighing 400 to 600 g, light green to white in colour. Does not require pandal.
Ribbed gourd	Co.1	125	14	Fruits long (60 - 75 cm) light green and weighs 300 g each.
	Co.2	120	25	Fruits are very long (1 m) green and fleshy.
	PKM.1	160	28	Fruits long, dark green with shallow grooves.
Bottle gourd	Co.1	135	36	Fruits round at the base and bottleneck at the top, light green, each weighs 2 kg.
Bittergourd	Co.1	115	14	Fruits green, 30 - 35 cm long, 100 - 200 g each.
	MDU.1	140	32	Fruits green and each weighs 410 g.
Ash gourd	Co.1	150	25	Fruits globular, green, large, oblong – oval in shape, ashy coated weighing 6 – 8 kg.
Cucumber	Co.1	100	25 – 28	Ripe fruits are bright yellow in colour with greenish yellow intermitant stripes.
Watermelon	PKM.1	120	37	Suitable for arid, semi-arid, irrigated conditions; pulp pink in colour; high TSS of 9.2° Brix.
Butter Beans	KKL.1	140	3.47	White seed; good cooking quality, suitable for hilly regions (1200 - 2000 m)
French Bean	TKD.1	90	5.6 - green pods 2.78 - dry seeds	Pods are less fibrous. Seeds turn white on maturity.
	YCD.1	105	9.7 – green pods 6.3 – dry seeds	Plants are semi dwarf and bushy. Pods are slightly flat, long, broad and robust.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
Dolichos Bean	Co.1	210	18 – green pods	Pods are dark green, flattish and slightly curled, tender and fleshy.
Moringa Beans	KKL.1	140 – 160	7 – green pods	Pods are fleshy and thick skinned.
Annual Moringa	PKM.1	2.5 years	52.8	Pods are 70 cm long weighs about 150 g.
Radish	Co.1	45	22	Roots milky white, less fibrous; suitable for growing throughout the year; set seed in plains.
Beetroot	Ooty.1	120 – 130 (direct sown) 135 – 150 (transplanted)	31.45	Roots are blood red colour with thin skin and good quality.
Garlic	Ooty.1	120 – 130	17.1	Bigger bulbs weighing 30 – 40 g each.
Palak	Ooty.1	2 years	15 (leaves)	Higher carotene in content. Rich in vitamins.
Cauliflower	Ooty.1	110 – 120	46.4	Compact uniform curds with attractive creamy white colour. Curd is free from ricyness and have good keeping quality.
Sweet potato	Co.1	135	28	Tolerant to root weevil; tubers with light pink skin and white flesh; starch content 24%
	Co.2	115	32	Tubers with light pink skin and white flesh; starch content 30%; tolerant to root weevil.
	Co.3	110	42	Tolerant to root weevil; tubers - light pink skin and orange flesh; high carotene content.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	Co.CIP-1	95 – 100	32	Short duration, resistant to root weevil, high market value.
Tapioca	Co.1	270	30	Tuber with whitish brown skin and white flesh; starch content 35%; field tolerance to mosaic virus; suitable for consumption and industries.
	Co.2	240-270	36	Branching type, flowers easily. Tubers with whitish grey and skin and creamy white flesh; starch 34.5%; moderately tolerant to mosaic virus; suitable for consumption and industries.
	Co.3	240	43	Shorter crop duration, branching type; high starch - 36% suitable for irrigated and rainfed cultivation.
Dioscorea	Co.1	240 – 255	44.8	Tubers are bigger with white flesh.
Coleus	Co.1	180 – 190	31.93	Tubers have 21.5% starch.
Onion	Co.2	65	12	Bulbs bigger (10 - 15 g) and crimson in colour; photo-insensitive type.
	Co.3	65	16	Bulbs light pink, bold (10-15 g) bulbs store well for 120 days.
	Co.4	65	19	Bulbs light pink, bold (12-15 g) with better consumers' appeal; bulbs store well for 150 days.
Amaranth	Co.1	20-25	7	Can be grown throughout the year (25 days - Mulakeerai) (50 - 60 days for Thandukeerai)
	Co.3	90	31	Plants dwarf; clipping type.
	Co.4	90	2.5 t grains	A grain amaranthus type, seeds are rich in protein (19.55 %) and aminoacid like lysine (7.5 mg per 100 g) can be substituted for minor millet like Ragi and Thenai

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	Co.5	120	10–Mulaikeerai 30 – Thandu-keerai	Single plant selection from A-166-1. Double coloured type with dual purpose. Suitable for container cultivation.
C. Spices and Condiments				
Coriander	Co.2	90-100	400-500 and 600-800 kg of grains/ha under dry and irrigated conditions respectively.	It is a dual purpose variety suited for greens and seed purpose.
	Co.3	85 – 90	644 kg grains/ha	Seeds are medium sized with attractive brownish yellow in colour.
Tamarind	PKM.1	Perennial	263.3 kg/tree	Bear fruits in clusters of 3 – 7 and the fruits are characteristically semicircular in shape. 39% pulp recovery.
Turmeric	BSR.2	240 – 250	32	Medium statured. Resistant to scale insects.
Fennel	Co.1	210 – 220	600-800 kg/ha	Suited for growing in plains as well as in lower hill slopes under irrigated and rainfed conditions. It can be grown as border crop with other long duration crops, and as intercrop in young plantation of Coconut and Arecanut gardens.
Fenugreek	Co.1	80 – 90	500-750 kg of grains/ha	It is a dual purpose variety suited for greens as well as grains. It yields 4000 kg of greens/ha when harvested at 25 days after sowing.
	Co.2	85 – 90	418.8 kg	Fairly resistant to root rot disease.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
Cinnamon	YCD.1	Perennial	3800 kg dried leaves per ha 359.75 quills per ha	Quills of sweet and light pungent.
D. Plantation Crops				
Cashew	VRI.1	Perennial	7 kg nuts/ tree/year	A high yielder bearing good quality nuts suitable for export.
	VRI.2	Perennial	8 kg nuts/ tree/year	A seedling selection, bearing high percentage of perfect flowers, with medium sized nuts and high shelling percentage (28%). Variability in seedling progenies is minimum.
	VRI.3	Perennial	14.19 kg nuts/ tree/year	Larger nuts. Shelling – 29.1 %
Palmyrah	SVPR.1	Perennial	298 lit padaneer per palm/year 140 fruits/ palm/year	It is semi dwarf, high jaggery content of 144 g/lit, high recovery of 13.16%, high brix value 13.3°C
Betelvine	SGM.1	2 – 2.5 years	109 lakh leaves/ha	Vines are dwarf vigorous, bushy in growth. Leaves posses attractive yellowish green colour with desirable pungency.
E. Commercial Flowers				
Hybrid Rose	YCD.1	Perennial	100-120 Nos/ bush/year	Suitable for hilly regions of above 1500 m. It is a free bloomer, good for bedding and decorative purposes. Flowers medium size (7-8 on diameter) Mostly bears in clusters. The colour of the flowers is pleasing yellow when opened.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	YCD.2	Perennial	150 – 200 Nos/ bush/year	Suitable for 1000 – 2000 m. Unopened flower bud is bright yellow with a scarlet red tinge at the tip. The just opened flower is scarlet red with yellow shade at the petal base. The fully opened flower is in pleasing scarlet colour.
Mullai	Parimullai	Perennial	8 t/ha	A selection from a medium point type; resistant to gall mite, medium long corolla tube.
	Co.1 Mullai	Perennial	10 t/ha	It has bold flower buds with long corolla tube enabling easy tying in garland making; suited for fresh flower marketing.
	Co.2 Mullai	Perennial	11.1 t/ha	Flower buds have long corolla tube and longer buds. Exhibits completely field tolerance to phyllody disease.
Jasmine (Pitchi)		Co.1 (Pitchi)	Perennial	11 t/ha Suitable for fresh flower market and also for extraction of floral concrete. The plants are fairly tolerant to salt water. Concrete recovery is 0.29 %
	Co.2 (Pitchi)	Perennial	11.68 t/ha	Bolder pink buds.
Chrysanthemum		Co.1	180-220	16.7 t/ha Yields 16.7 t/ha in the main crop. Flowers early by 15 days than local varieties; blooming period is also longer by 15 days.
	Co.2	190	20 t/ha	Flowers – purple colour; It scores over Co.1 in number of flowering shoots per plant and no of flower per plant.
	MDU.1	180-200	30.6 t/ha	Suitable for southern districts. Yield 30.6 t/ha inclusive of ratoon crops.
Gerbera	YCD.1	Perennial	60 flowers/ plant/year	Suitable for cut flower, raising as borders in garden and for pot cultivation.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	YCD.2	Perennial	80 flowers/ plant/year	Blooms throughout the year. Flowers are attractive rosy pink coloured born on long stalk without bend.
Hibiscus	Co.1 Thilagam	Perennial	3000 flowers/bush	The plant bears attractive crimson red double flowers; petals are arranged in three whorls. Profuse flowering variety and is suitable for specimen and foundation plantings.
	Co.2 (Punnagai)	Perennial	(1000 flowers/ year/bush)	The flowers are large, very attractive and of apricot yellow colour. The petals have paper like texture with feeble veins radiating from the throat.
	Co.3	Perennial	1300 flowers/ bush/year	Produce apricot yellow flowers with signal red throat. The flower colour gradually changes into Chinese yellow with turkey red throat in the afternoon.
Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
Gladiolus	KKL.1	Perennial	21.1 t/ha	Longer spikes with 162 flowers per spike. Attractive red purple colour with white fleshed centre.
Barlaria	Co.1	Perennial	9.4 t/ha	The colour of the flower is attractive pink; plants are drought tolerant and free from pests and diseases. It is in full bloom when the other important commercial flower crops cease their flowering by November.

Part VIII

Seed Production Technology of Horticultural Crops

Tomato

Seed rate

300 g/ha.

Nursery treatment

15 days before sowing drench the nursery with Metham sodium @ 28 ml/sq.m. for controlling the nematodes. After 7 days drench with Copper oxychloride @ 5 g/lit to prevent damping off.

Age of seedling 25 - 30 days.

Spacing

Co 1	:	60 x 60 cm
PKM 1	:	75 x 60 cm
Co 2	:	80 x 75 cm
Pusa Ruby	:	80 x 70 cm
Co 3	:	60 x 30 cm

Fertilizers

Total	:	150 : 100 : 100 NPK kg/ha
Basal	:	75 : 100 : 100
Top dressing	:	At the time of flowering with 75 kg N.

Foliar application

NAA @ 20 ppm 65 and 75 days after transplanting followed every time by spraying urea at 12 kg N, Super phosphate 4 kg, 2 kg Potassium sulphate and 200 g of micronutrient mixture dissolved in 100 lit of water/acre.

Harvest

Seeds attain maturity 30 – 35 days after flowering.

Harvest fully matured, red, ripened and healthy fruits. First 8 - 10 pickings alone should be used for seed extraction.

Seed extraction

Well matured fruits are crushed and made into a pulp. For every 1 kg of pulp add 20 - 30 ml of commercial HCL acid, kept it for 30 min. with constant stirring. At the end of 30 min. wash the seeds 3 - 4 times with water and air dry the seeds.

Grading

BSS : 12 x 12 wire mesh (2.1 mm) sieve are used.

Storage

Dry the seeds to 7 - 8 % moisture and treat with Thiram or Captan 75 % WP @ 2 g + 200 mg Sevin 50 % WP/kg of seeds or Halogen formulation (Bleaching power + CaCo3 + arappu leaf powder @ 5:4:1) @ 3 g/kg. The treated seeds can be stored upto 12 months in paper bags and upto 24 months in moisture vapour proof containers.

Brinjal

Season

June - July.

Seed rate

450 g/ha.

Nursery preparation

15 days before sowing drench the nursery with Metham sodium @ 28 ml/sq.m. for controlling the nematodes. After 7 days, drench with Fytolan @ 5 g/lit of water against damping off disease.

Age of seedling : 30 - 35 days.

Fertilizers

Total : 100 : 75 : 75 kg NPK/ha

Basal : 50 : 75 : 75 kg NPK/ha

Top dressing : 50 kg N/ha just before flowering.

Spacing

75 x 60 cm.

Supplemental foliar application

NAA @ 20 ppm 65 and 75 days after transplanting followed every time by spraying urea at 12 kg N, Super phosphate 4 kg, 2 kg Potassium sulphate and 200 g of micronutrient mixture dissolved in 100 litre of water per acre.

Harvest

Seeds attain maturity in 40 - 45 days after flowering. The symptom of harvestable maturity is turning of the skin colour from green to bright yellow. Medium size fruits yield more quantity and quality seed than big or small fruits.

Seed extraction

The well ripened fruits are cut into 4 – 6 pieces and softened by soaking in water overnight. On extraction the floaters are removed.

Grading

Sieve size : 5/64" round perforated metal sieve or BSS 12 x 12 wire mesh sieve (2.1 mm)

Storage

Treat the seeds with either Captan or Thiram @ 2 g + Sevin 50 % WP 200 mg/kg of seed or halogen formulation @ 2 g/kg and store upto 1 year in cloth bag and upto 2 years in moisture vapour proof containers.

Bhendi

Season

March, April and May.

Seed rate

8 - 10 kg/ha.

Spacing

60 x 20 cm.

Fertilizers

Basal : 40 : 50 : 30 kg NPK/ha.

Top dress : 20 : 50 : 30 kg NPK/ha.

i) 10 kg N/ha at first flowering

ii) 10 kg N/ha 10 days after flowering.

Foliar application

DAP at 0.5 % thrice at 10 days interval commencing with first flowering enhances the yield of good quality seeds.

Harvest

Seed matures 28 - 30 days after anthesis. Harvest the pods when they dry and turn brown

and develop hair line cracks along the ridges. In Bhendi, first formed two pickings can be used for vegetable purpose and the next 6 pickings can be used for seed purpose.

Seed extraction

Harvested pods can be dried in the sun for 2 - 3 days and seeds can be extracted in a machine thresher or by hand with pliable bamboo stick.

Grading

Sieve size : 10/64" round. Perforated metal sieve or BSS 6 x 6 wire mesh sieve (4.2 mm)

Upgrading : To remove the empty seeds water floatation technique is adopted. Air-dry the seeds.

Seed storage

Seeds can be easily stored when they are dried to 8 % moisture content and treated with Halogen formulation @ 2 g/kg or Captan 75 % WP 4 g/kg upto 15 months in cloth bag and 24 months in moisture vapour proof containers.

Chillies

Season

June - July.

Seed rate

1 kg/ha.

Age of seedling : 30 - 35 days.

Fertilizer

Basal : 0:70:70 kg NPK/ha.

Top dress : 50 kg N 15 days after transplanting, 50 kg N 45 days after transplanting and 40 kg N 90 days after transplanting.

Spacing

60 x 30 cm.

Foliar application

NAA @ 20 ppm 65 and 75 days after transplanting followed every time by spraying urea at 12 kg N, Super phosphate 4 kg, 2 kg Potassium sulphate and 200 g of micronutrient mixture dissolved in 100 lit of water/acre.

Harvest

Seeds mature in about 40 - 45 days after planting. Harvest the fruits when they are capsicum red in colour. Fruits obtained from first 5 to 6 pickings alone used for seed extraction.

Seed extraction

Dried fruits are taken in gunny or cloth bag and threshed with a pliable bamboo stick or chilli seed extraction can be used. The seeds are separated and graded.

Grading

BSS 8 x 8 wire mesh sieve or 8/64 round perforated metal sieve (3.1 mm).

Storage

Intact pods can also be stored upto 20 months. Seeds dried to 7 - 8 % moisture content and treated with Captan/Thiram 75% WP @ 4 g/kg or Halogen formulation @ 3 g/kg. Can be stored upto 10 months in cloth bag and upto 18 months in moisture vapour proof containers.

Pumpkin

Sowing

June - July and January – February.

Seed rate

1 kg/ha.

Spacing

Pit size : 45 x 45 cm at 2.5 x 2.0 m.

Manuring

100 g of the mixture (6:12:12) per pit as basal and 10 g N/pit 30 days after sowing.

Foliar application

Maleic hydrazide @ 400 ppm at 2 leaves stage and 5 leaves stage enhances the female flower production or application of Ethrel at 100 - 200 ppm at weekly intervals from first 4 leaf stage. During the course of fruit development apply urea at 12 kg N/ha, Super phosphate at 4 kg/ha, Potash at 2 kg/ha and micronutrients 400 g/ha.

Harvest

Seeds attain maturity 16 weeks after flowering. Harvest the fruits when surface of the fruits turn waxy and shiny. The colour changes to yellow or orange yellow at full maturity and fruits stalk become dry.

Fruits weighing less than 1.5 kg should not be used for seed extraction.

Seed extraction

Fruits are cut and seed with pulp are scooped out and seed are separated washed with water and dried.

Grading

BSS 4 x 4 wire mesh sieve (6.2 mm) or 16/64" round perforated metal sieve.

Storage

Seeds dried to 7 - 8 % moisture content and treated with Captan/Thiram 75 % WP@ 2 g/kg or halogen formulation @ 3 g/kg can be stored for 10 months in cloth bag and 18 months in moisture vapour proof container.

Snake gourd

Sowing

July - December and January - June.

Pre-sowing treatment

Pre-germination of seeds by soaking in double the volume of water for 4 hours enhances the field standard.

Seed rate

1.5 kg/ha.

Spacing

Dig pits of size 45 x 45 cm at 2.5 x 2.0 m spacing.

Manuring

100 g of the mixture (6:12:12) per pit as basal and 10 g N/pit 30 days after sowing.

Foliar application

Maleic hydrazide @ 400 ppm at 2 leaves stage and 5 leaves stage enhances the seed yield and quality or application of Ethrel @ 100 - 200 ppm at weekly intervals from leaf stage. During the course of fruit development apply urea at 12 kg N/ha, Super phosphate at 4 kg/ha, Potash at 2 kg/ha and micronutrients 400 g/ha.

Harvest

Fruits can be harvested at visible yellow to orange skin initiation stage.

Seed extraction

Manual labour is to be employed.

Grading

The immature seeds can also be removed as water floaters during wet extraction. After drying the seeds, the immature and small sized should be removed as air blown rejects. 16/64" round holed sieve may be used or BSS 4 x 4 (6.2 mm)

Storage

Seeds dried to 7 - 8 % moisture content and dry dressed with Thiram/Captan 75 % WP or halogen mixture @ 3 g/kg @ 2.5 g/kg of seeds and stored in cloth bag upto 10 months and over 18 months in moisture vapour proof containers.

Bottle gourd

Sowing

June - July and January - February.

Seed rate

3 kg/ha.

Foliar application

Maleic hydrazide @ 400 ppm at 2 leaves stage and 5 leaves stage enhances the seed yield and quality or application of Ethrel @ 100 - 200 ppm at weekly intervals from 4 – 6 leaf stage. During the course of fruit development apply urea at 12 kg N/ha, Super phosphate at 4 kg/ha, Potash at 2 kg/ha and micronutrients 400 g/ha.

Harvest

Fresh fruits at 65 days after anthesis (the skin of the fruit become rough and turn dull in colour) can be harvested. The immature seeds can be removed as floaters. Fruits weighing less than 50 g should be rejected as it contains more than 5 % immature seeds.

Seed extraction

Matured fruits are cut vertically and seeds are scooped and cleaned.

Grading

16/64" round perforated metal sieves or BSS 4 x 4 wire mesh sieve (6.2 mm)

Storage

Seeds dried to 8 % moisture content and treated with Thiram 75 % WP @ 4 g/kg or halogen formulation @ 3 g/kg can be stored upto 1 year in cloth bag and 2 years in moisture vapour proof containers.

Ash gourd

Sowing

January - May and June - November.

Seed rate

2.5 kg/ha.

Manuring

100 g of the mixture (6:12:12) per pit as basal and 10 g N/pit 30 days after sowing.

Foliar application

Maleic hydrazide @ 400 ppm at 2 leaves stage and 5 leaves stage enhances the seed yield and quality or application of Ethrel @ 100 - 200 ppm at weekly intervals from 4 leaf stage. During the course of fruit development apply urea at 12 kg N/ha, Super phosphate at 4 kg/ha, Potash at 2 kg/ha and micronutrients 400 g/ha.

Harvest

Seeds can be harvested at 80 - 85 days after anthesis when fruit stalk becomes dry and ashy coat prominent. Fruits weighing less than 2.5 kg should be rejected.

Seed extraction

Fresh fruits can be used for extraction. On fresh extraction immature seeds can be removed as floaters. Cutting the fruits into longitudinal bits and soak in 1:6 concentrated HCL acid for 30 minutes.

Grading

The smaller seeds could be removed as air blown rejects in pneumatic seed blower and graded by using 16/64" dia. Round holed sieve round perforated metal sieves or BSS 4 x 4 wire mesh sieve (6.2 mm)

Storage

Fruit storage

i) Half matured fruits available at the last harvest stage can be removed and stored over sand bed at ambient condition. On dry storage seed develops and can be used for seed extraction. Facilitate early field release.

ii) Fruits weighing not less than 2 kg without bruishes and proper protection from insect, pathogen and rodents can be stored over sand bed for more than 6 months. The loss in fruit weighting amount to 35 % and germination of 80 – 90 %

iii) Processed seeds weighing not less than 10 g/100 seeds at 10 % moisture content should be dried to 8 % moisture content and treated with Thiram 75 % WP @ 4 g/kg of seeds halogen formulated @ 3 g/kg for extended storage and packed in moisture vapour proof containers.

Cluster beans

Variety

Pusa naubahar.

Season

June - July (irrigated)

Seed treatment

Treated with Captan 75 % WP @ 2 g/kg.

Sowing

Dibbled @ 2 seed/hole on the sides of the ridges.

Spacing

45 x 20 cm.

Foliar application

DAP 2 % spray at 50 % flowering stage.

Manures and fertilizers

FYM 20 t/ha.

Fertilizers	N	P	K	Remarks
Total	50	50	25	
Basal	25	50	25	Just before sowing
Top dress	25	-	-	At first flowering.

Harvest

Attains physiological maturity at 58 - 60 days after anthesis and reach harvestable maturity 64 - 65 days. The harvest is done by two staggered pickings as soon as the pods turn into brown colour.

Processing

Seed should be graded by using 10/64" round perforated metal sieve or BSS 6 x 6 wire mesh sieve (4.2 mm).

Seed treatment

Slurry treated with either Captan or Thiram 75 % WP @ 2 g/kg of seed or halogen formulation @ 3 g/Kg.

Storage

Seeds dried to 8 % moisture content can be safely stored in moisture vapour proof container for two years.

Cowpea

Season

June – July and February – March.

Spacing

45 x 20 cm.

Fertilizers

25:50:0 kg NPK/ha.

Foliar application

Spray 1% DAP at 50% flowering. The tendril clipping enhances flowering and fruit yield.

Harvest

25 – 30 days after flowering the seed matures (fruit become straw yellow colour). The crop harvested in pickings with an interval of 15 days. The early pickings upto 4 can be used for extraction.

Seed extraction

By heating with pliable wooden stick.

Grading

12/64" dia round perforated metal sieve or BSS 5x5 wire mesh (4.8 mm).

Storage

Seed treatment with activated clay @ 1:100 by weight or Captan or Thiram 2 g + 75% WP sevin 200 mg/kg of seed. The treated seed can be stored upto 8 months in cloth bag and 16 months in moisture vapour proof container provided there is no bruchid infestation.

Dolichos bean

Season

March - April.

Spacing

60 x 20 cm.

Fertilizers

25:50:0 kg NPK/ha.

Foliar application

NAA @ 20 ppm 65 and 75 days after transplanting followed every time by spraying urea at 12 kg N, Super phosphate 4 kg, 2 kg Potassium sulphate and 200 g of micronutrient mixture dissolved in 100 lit of water/acre.

Preharvest sanitation spray

With Endosulfan 0.7 ml/lit 5 days prior to harvest reduces bruchid damage.

Harvest

When the pods turn to straw yellow colour. Last two pickings can be used for vegetables.

Seed extraction

Threshing with pliable wooden stick.

Grading

18/64" dia round perforated metal sieve or BSS 3x3 wire mesh sieve (7.2 mm).

Storage

Seed treatment with activated clay @ 1:100 by weight or Captan or Thiram 75% WP 2 g + Carbaryl 200 mg/kg of seed. The treated seed can be stored upto 8 months in cloth bag and 16 months in moisture vapour proof container provided there is no bruchid infestation.

Annual moringa

Spacing

3 x 3 m.

Sowing

2 to 3 seeds/pit.

Fertilizers

100:200:50 g NPK/tree. N applied in 3 split doses.

Foliar application

NAA @ 20 ppm followed by urea 2 kg, Super phosphate 4 kg + 400 g micronutrient mixture/ha at flowering at early stage of fruit growth 3 - 4 sprays at 10 days interval. 3 ratoon crops can be taken up without reduction in quality.

Seed maturation

Seed attains physiological maturity at 70 days after anthesis with maximum germination and

vigour with a colour change of pod from green to brown. Fruits can be harvested from 70-75 days after anthesis and delayed harvest leads to shattering and loss in seed quality.

Seeds within the pod vary in colour and among these black coloured seeds have higher weight, germination and vigour when compared to light brown and white seeds.

Grading

Seed should be graded by using 24/64" round perforated metal sieve.

Storage

Seed treated with Thiram 75% WP @ 2 g/kg and can be stored in cloth bag for one year.

Radish

Root to seed method

When the roots are fully mature the crop is harvested. True to type roots are selected and transplanted in a well prepared field.

Seed to seed method

Seeds are sown in well prepared land. On 45 days tubers are lifted out and then transplanted with one third top cut.

Fertilizers

Basal	:	50:25:50 kg NPK/ha.
Top dressing	:	50 kg N just before flowering.

Foliar spray

DAP @ 2 kg/ha thrice at 10 days interval during flowering increases the yield and quality of seeds.

Harvest

Seed matures 35 - 40 days after anthesis. Harvest the pods when they dry and turn creamy straw colour. Drying intact in the plant enables a single harvest and does not affect quality.

Seed extraction

Thresh the seeds with a pliable bamboo stick.

Grading

The separated seeds should be graded by using 8/64" sieve or BSS 8 x 8.

Storage

Slurry treat the seeds with Captan or Thiram 2 g + Sevin 200 mg dissolved in 5 ml of water/ kg of seed and pack in cloth bags.

Bellary onion

Seed rate

6 - 8 kg of graded seed/ha.

Nursery

Treat the seed with Thiram or Captan 2 g/kg.

Sow seeds during May - June in lines drawn 5 cm apart.

Transplanting

Seedlings at age 35 - 40 days may be transplanted in the mainfield on both sides of the ridges and furrows.

Spacing

20 x 10 cm.

Fertilizer application

FYM 10 t/ha.

Application	N	P	K
Basal kg/ha	30	60	30
Top dress (30th day) kg/ha	30	-	-

Harvest

Harvest at 110 - 115 days, the well matured bulbs.

Bulb grading

Select medium sized bulbs of weighing 40 - 50 g.

Bulb treatment

Remove the top 1/4th of the bulb and treat with fungicides of Carbendazim or Quintozene or Mancozeb at 20 g in 10 lit of water for 5 – 10 minutes.

Bulb sowing

Sow the treated bulbs on ridges and furrows during October - November.

Spacing

50 x 20 cm.

Harvest

Harvest the earheads during March when 50 % of the seeds in umbels turn to black colour to prevent the shattering lose.

Seed extraction

Dry the earheads under sun and extract the seeds.

Seed grading

Size grade the seeds by using BSS : 10 x 10 wire mesh sieve (2.5 mm) or 6/64" round perforated metal sieve.

Seed yield

500 - 600 kg/ha.

Seed storage

Dry the seeds to reduce the moisture content to 6 - 8 % and treat with Captan at 2 g/kg and store the seeds in polythene bags.

Amaranth

Season

June – July.

Seed rate

2.5 kg/ha.

Spacing

45 x 20 cm.

Fertilizers

75:25:25 kg NPK/ha.

Foliar spray

Give two sprays with Urea (12.5 kg N/ha) and micronutrients (450 g/ha) from commencement of flowering at 10 days interval.

Harvest

Seed attains maturity 35 – 45 days after flowering. When glumes turn brown in colour and seeds turn black.

Seed extraction

Seeds are extracted by beating with pliable bamboo sticks and dried to 7 – 8 % moisture content.

Grading

Seeds are graded using 2/64" round perforated metal sieve.

Storage

Graded seeds are treated with Captan or Thiram 50% WP @ 2 g/kg can be stored for 10 months in cloth bag and 18 months in moisture vapour proof containers.

Carrot

Root to seed method

Stecklings weighing 150g and above can be used for planting. Stecklings having low weight reduce the seed yield and seed quality.

Fertilizers

Basal

50:50:10 Kg NPK/Ha

Top dressing

50 kg N prior to flowering

Harvest

Seeds in the umbel mature 7 weeks after anthesis. Splitting of Schizocarp into two mericarp occurs at this time. Delayed harvest results in shattering.

Grading

BSS 12 x 12 wire mesh sieve.

Storage

Dry seeds to 8% moisture content and treat with Captan 2g + Carbaryl 200 mg/kg of seed and pack in 700 gauge polythene bag,

Germination Improvement

Remove empty seeds by density grading (using a seed blower) soak seeds in water for 72 hours with a change of water every 24-hours to leach out the inhibitors present on the seed coat. This will improve the germination upto 65%.

Cauliflower

Foliar application

Foliar application of DAP 20 g/lit at 30 days after curd formation as supplementary nutrition increases the yield of good quality seeds.

Harvest

Seed matures 7 weeks after flowering. Delayed harvest reduces germination significantly.

Storage

Cauliflower seeds produced at Nilgiris stored better at Coimbatore upto 10 months.

Dry the seeds to 8-10% moisture and mix with fine neem leaf powder (1:50 ratio)

Seeds treated with halogen formulation @ 3 g/kg can be stored for 10 months in cloth bag.

1. Papaya

Germination improvement

Soak seeds in 100 ppm GA_3 for 16 hours or in 2% fresh leaf extract of arappu or 1% pungam leaf extract or pellet the seeds with arappu leaf powder.

Optimum depth of sowing

Sow seeds at 1 cm depth for better germination and seedling growth.

Seed extraction

Fruit size or weight has no association with seed quality except that the seed content is more in large fruits and less in small fruits. The seeds from different fruit weight or size classes did not differ in their quality. Hence, all ripened fruits can be used for seed extraction.

Grading

BSS 6 x 6 wire mesh sieve (4.2 mm).

Storage

Dry seeds to 8-10% moisture and treated with halogen mixture containing $CaOCl_2$, $CaCO_3$ and arappu leaf powder (at 5:4:1 ratio) @ 3g/kg and pack in cloth bag to maintain viability upto 5 months.

Invigoration of old seeds:

Stored seeds can be invigorated by soaking them in dilute solution of disodium phosphate (10-4M) adopting 1:8 seed to solution ratio for 4 hours followed by drying back to original moisture content.

2. Ber

Seeds of ber attain physiological maturity 13 weeks after anthesis. It is indicated by yellowish red colour of fruit pericarp. Stones can be size graded using 22/64" round perforated metal sieve. The stones soaked in Thiourea 20 g/lit for 24 hours enhances the germination. Ber stones can be stored upto 30 months without any treatment under ambient conditions. Stone grading done with 20% Sodium chloride removes illfilled and empty stones.

3. Amla

Stratify the fresh seeds in sand moist to 60% with KNO_3 5 g/lit kept at 5°C for 10 days to remove the morphophysiological dormancy. Dry storage of fresh seeds for 10 months can also remove this dormancy.

Seeds attain physiological maturity 23 weeks after termination of fruit dormancy of 5 months when the fruit colour turns to yellowish green and seed colour chestnut brown. Amla seeds can be extracted by soaking the fruits in 30% brine solution during night followed by drying during the day and repeated for 3 days. The mesocarp following soaking in brine solution remained fresh and can be used for pickle/byproducts preparation.

Using 8/64" round perforated metal sieve with maximum seed recovery can process seeds. The size-graded seeds can be further upgraded by density grading using water to remove the light weighted empty seeds. Seed treated with Thiram 75% WP at the rate of 4 g/kg + Carbaryl 50 % WP @ 400 g/kg can be stored upto 18 months in cloth bag and at 24 months in moisture proof container.

4. Jamun

Jamun seeds attain physiological maturity 11 weeks after anthesis where the fruit colour ohanges to purplish black.

For better seed extraction, heap the collected fruits for one day and squeeze with. Seeds come out easily.

Fresh seed can be size graded using 20/64" round perforated metal sieve with maximum seed recovery. It is a recalcitrant seed and will loss viability upon storage due to desiccation (drying). When stored seeds are to be used for sowing, the dead seeds can be removed by density grading using water. The seeds lose viability completely with in one month in tropical condition when the moisture content of seed falls below 20%. The critical moisture for safe storage is around 45%.

Packing of seeds in polyethene bags containing 2% moist sand stored at 10°C in refrigerator storage prolongs viability upto 3 months.

Medicinal Plants

Gymnema

Seeds will attain physiological maturity 100 days after anthesis with colour change of pods from green to dark brown. Leaching the seeds in tap water for 12 hrs followed by soaking in KNO_3 2 g/lit for 6 hours recorded higher germination. Density grading using South Decota air blower at 0.5" water pressure improves seed germination. Seed treatment with Thiram 75% WP @ 2 g/kg and packed in moisture vapour proof container prolongs viability.

Senna

Season

November – December and June – July.

Seeds attain physiological maturity at 40 days after anthesis associated with colour change of pods from green to brown. Seed can be processed by using 8/64" round perforated metal sieve. Hard seededness can be effectively overcome by acid scarification with commercial sulphuric acid @ 100 ml/kg seed for 10 minutes. Seed treatment with Thiram @ 2 g/kg packed in moisture vapour proof container prolongs the viability upto 15 months.

Periwinkle

The physiological maturity of periwinkle seeds will attain at 40 days after anthesis with maximum dry weight, germination and vigour with a change of pod colour from green to yellow with translucence.

Seeds can be processed by using 4/64" round perforated metal sieve with maximum seed recovery.

Storage

Seed treatment with Thiram @ 2 g/kg packed in moisture vapour proof container prolongs the viability upto 15 months.

Roselle

Seeds attain physiological maturity at 40 days after anthesis. Seeds can be processed by using 7/64" round perforated metal sieve (2.8 mm).

Pre-sowing seed treatment and Storage

Seed treatment with Thiram @ 2 g/kg packed in moisture vapour proof container, prolong the viability upto 15 months.

Aromatic Plants

Palmarosa Cv. Trishna

Seeds attain physiological maturity at 40th day after 50% flowering when the fluff (seed) moisture is around 20%. Leaching of fluffs in running water for 8 hours followed by soaking in KNO_3 at 0.5% for 6 hours recorded maximum germination.

Density grading using South Decota air blower at 0.5" water pressure improves seed germination. Seed treatment with Thiram 75% WP @ 2 g/kg and packed in moisture vapour proof container prolongs viability.

Storing of fluffs in 700 gauge polyethylene bags after seed treatment with Thiram 75 % WP @ 2 g/kg maintains the shelf life of fluffs upto 10 months.

Part IX

Important Plant Nutrients their Deficiency Symptoms and Remedial Measures

I. MACRONUTRIENTS

1. Nitrogen

Symptoms

1. Chlorosis beginning in older leaves. Tips and margins of leaves commonly become yellow first.
2. Stunted growth.
3. Early crop maturity and low production.

Remedial measures

Spray 500 g of Urea dissolved in 100 lit of water to leaves.

2. Phosphorus

Symptoms

1. Older leaves become dark green with purple coloration (due to anthocyanin development) in some species.
2. Stunted shoot growth and poor root development.
3. Delayed crop maturity.

Remedial measures

Use Super phosphate or bone meal in required quantities.

3. Potassium

Symptoms

1. Symptoms first appear on recently matured leaves and become pronounced on older leaves. Dark green foliage with necrotic spots appearing on older foliage, typically at tips and margins and entire leaf blade becomes scorched or necrotic.

2. Slow growth and susceptibility to wilting.
3. Potassium is important for fruit taste, size and colour.

Remedial measures

Spray 500 g of muriate of Potash or Sulphate of Potash dissolved in 100 lit of water.

4. Calcium

Symptoms

1. Reduced growth or even death of apical meristems, often leading to multiple branching in tap root crops.
2. Young foliage may be abnormal, chloritic or even 'burned' at tips.
3. Softening of tissues and cell wall breakdown is common in fruits.

Remedial measures

Apply 2 to 4 kg of lime once in two years to each plant.

5. Magnesium

Symptoms

1. Deficiency symptoms first appear in older leaves with chlorosis between veins and along margins progressing inward intervenially.
2. Tips and margins and leaves turn upwards.
3. Leaves tend to be brittle and may fall prematurely.

Remedial measures

Spray 100 g of Magnesium sulphate in 100 lit of water or apply 25 - 125 kg of Magnesium sulphate to the soil.

6. Sulphur

Symptoms

1. Symptoms are similar to 'N' deficiency with plants tend to be small and spindly having slender and short stalks.
2. Young leaves chlorotic, principal veins typically green.
3. Delayed maturity.

Remedial measures

Apply 20 - 25 kg of Sulphur per ha.

II. MICRONUTRIENTS

Like the macronutrients such as Nitrogen, Phosphorous, Potassium, Calcium, Magnesium and Sulphur, a score of micronutrients play a pivotal role in growth, development and reproductory activities of any crop plant.

The micronutrients such as Iron, Manganese, Boron, Copper, Zinc, Molybdenum, Chlorine and Silicon, etc., are extremely essential for sustained growth and productivity. Their essentiality is there for both seasonal and perennial crops, and their shortage quite apparently manifests in visible deficiency symptoms characterised by stunted growth, narrow or little leaves, chlorosis, crinkling, cupping and other leaf deformities, flower drop, alteration of sex of flowers, poor pigmentation and quality, cracking of stem, die back and oozing of gum. Each micronutrient is capable of producing one or more specific deficiency symptoms if it is in short supply to the plant metabolism. Often the complex deficiency symptoms as a result of deficiency of more than two micronutrients are manifested in sensitive crops such as Limes, Sweet Oranges, Mandarins and Lemons, etc.

1. Iron

It is essential for the development of chlorophyll in crops.

General symptoms

1. Young leaves become chlorotic.
2. The principal veins typically green, with absence of green colour in the finest veins and progress of chlorosis may lead to leaves completely devoid of chlorophyll leading to stunted crop growth.

Remedial measures

Spray 250 - 500 g of Ferrous sulphate dissolved in 100 lit of water.

i. Citrus

Symptoms

Pale yellow and small sized leaves, stunted growth and small sized fruits.

Correction

Foliar spray of 0.1 % Ferrous sulphate solution.

ii. Grapes

Iron deficiency in grapes is due to the presence of excess Calcium in the soil.

Symptoms

Pale yellow small leaves with stunted growth.

Remedy

Apply Sulphur containing fertilizers.

iii. Pineapple

The deficiency is prevalent in the soils with more Calcium and Magnesium.

Symptoms

Reddish green leaves.

Remedy

0.1 % Ferrous sulphate solution sprayed with an interval of one month.

iv. Vegetables

Iron is essential for the initial growth of vegetable crops. So it is essential to apply Iron containing fertilizers at the initial stage of development to avoid iron deficiency in vegetable crops.

Iron deficiency is common in the crops like Beans, Cauliflower, Beetroot, Brinjal, tomato and Tapioca.

Symptoms

Pale yellow leaves, drying of leaf tips and in severe deficiency drying of whole leaves may occur.

Remedy

Apply 25 kg Ferrous sulphate per ha or spraying 0.5 % Ferrous sulphate solution at the time of 3 - 4 weeks after sowing/transplanting.

2. Manganese

Symptoms

1. Intervenial chlorisis which shows up in younger leaves first.
2. Dark green bands along midrib and main veins with lighter green areas between the bands.

Remedy

Spray lime mixed Manganese sulphate.

3. Boron

General symptoms

1. Stunted growth or death of apical meristems, followed by sprouting of lateral buds.

2. Leaves, petioles or stems may be thickened, wrinkled curled and chlorotic.
3. The fleshy part may show brown flecks, necrosis, cracks or dry rot.
4. Death of meristems causes reduced flower and fruit set.

It is essential for the translocation of photosynthesis in plant system. Its essentiality is obvious in Potato, Tapioca, Cabbage, Grapes, Citrus, Tomato and Guava.

i. Mango

Symptoms

Drying of leaves. This is more prevalent in the orchards, which are nearer to brick factories.

Remedy

Either by soil application of 500 g Borax per plant or by spraying 1 % Borax solution.

ii. Citrus

Remedy

Symptoms

Red spots on newly emerged leaves, leaves become dry and brittle.

Spraying 0.3 % Boric Acid.

iii. Guava

Symptoms

Splitting of fruits, gummosis at the splitted area, rough skin of the fruits.

Remedy

Spraying 1 % Borax solution.

iv. Grapes

Symptoms

Small sized fruits. Presence of small sized fruits and large sized fruits in the same bunch is known as "Hen and Chicken" disease. The fruits are sour in taste.

Remedy

Spray 1 % Borax solution.

v. Vegetables

a. Cabbage

Symptoms

Leaves become crinkled, rough and brittle. Drying of leaf edges soft spots on the petioles and loose heads.

In hybrid cabbage varieties, heads will not be formed and the leaves become blue in colour.

b. Cauliflower

Symptoms

Browning of leaf margin in young buds. Pale yellow veins and drying of leaves, the flower heads are long and dried with hollow flower stalk.

c. Radish

Symptoms

Tip drying, pale yellow leaves at initial stages and bluish green leaves at later stages. The leaves become crinkled and brittle. Early flowering.

d. Carrot

Symptoms

Wilting of plants despite enough soil moisture in the field. Deformed leaves with pale yellow colour.

e. Potato

Symptoms

Leaves become small and it resembles virus disease infected plant. 30 - 40 % yield loss and sometimes 100 % loss may occur.

Remedial measures for vegetables to correct Boron deficiency

i) For Cabbage, Cauliflower, Tomato, Chillies, application of 40 g Borax per cent area in nursery will produce elite seedlings.

ii) Borax 0.6 kg to 1.2 kg per ha is applied as fertilizer in the main field.

iii) For root and tuber crops apply Borax @ 1.2 kg to 3.2 kg/ha

vi. Coconut

Symptoms

Button shedding, hallownut and sometimes fruits without nut.

Correction

Apply Borax 0.6 - 1.2 kg/ha.

4. Copper

1. Stunted growth, Rosetting and dieback of young twigs in fruit trees.
2. White tipped leaves are early symptoms.
3. Reproductive growth strongly affected leading to sterility.

i. Banana

Symptoms

Leaf bud is crinkled and twisted. Delay in flower emergence.

ii. Coconut

Symptoms

Stunted growth, non-splitting of leaves.

iii. Citrus

Symptoms

Die back, splitting of bark, gummosis from fruits and browning of fruits with rough skin.

Remedial measures

Foliar application of 0.05 - 0.10 % Copper sulphate solution.

5. Zinc

1. Chlorosis often appears as yellow mottling, between the veins in younger le
2. Reduced stem growth may cause 'rosette' condition of terminal leaves.

i. Mango

Symptoms

Stunted growth, leaves small brittle and intervenal chlorosis, little leaves – rosette appearance.

Remedial measures

Two sprays of 1 - 2 % Zinc sulphate, one at the time of flowering and the other at 1 month after the first spray.

ii. Banana

Excess Phosphorous application leads to the deficiency of Zinc.

Symptoms

Narrow leaves with pale yellow colour.

Remedial measures

Spray 0.5 % Zinc sulphate or apply 30 g Zinc sulphate per plant.

iii. Citrus

Symptoms

Small, narrow, pale yellow leaves. Small fruits with rough skin.

Remedial measures

Three sprays of 0.5 % Zinc sulphate at the time of new flush emergence. Apply 500 g of Zinc sulphate per tree.

iv. Guava

Symptoms

Intervenal chlorosis, small leaves, rough leaf surface with cracks. Small rough skinned fruits and splitting of fruits.

Remedial measures

Spray 0.5 % Zinc sulphate solution 2 times before flowering with the interval of 15 days or apply 340 g Zinc sulphate before flowering.

v. Grapes

Symptoms

Small leaves, widened petioles and small sized fruits.

Correction

Smear 10 % Zinc sulphate on the pruned stem or spray 1 % Zinc sulphate solution 10 days before flower formation.

vi. Vegetables

a) Beans

Symptoms

Dropping of leaves and flower buds and intervenal chlorosis.

b) Tomato

Symptoms

Stunted growth, thickening of leaves, intervenal chlorosis, shortened internode, dropping of flowers and immature fruits.

c) Radish

Symptoms

Intervenal chlorosis at the initial stage and drying of leaves at later stages.

d) Onion

Symptoms

Tip drying during initial stage and total drying of leaves at later stages.

Remedial measures

i) Seed treatment with 0.01 % Zinc sulphate.

ii) Spray 0.25 - 0.50 % Zinc sulphate solution in the nursery five weeks after germination.

iii) Foliar application of 0.1 % Zinc sulphate in the field.

vi. Coconut

Button shedding is the common symptom. The deficiency can be corrected by application of 0.25 % Zinc sulphate per plant.

6. Molybdenum

1. Chlorotic interveinal mottling of the lower leaves followed by marginal necrosis and infolding of the leaves.
2. In severe conditions necrosis and wilting of leaves occur.
3. Flower formation is inhibited, and if flowers do form, they abscise before setting fruits.

i. Cauliflower

Symptoms

Drying of leaves from its edges at initial stages, later stages total drying. Leaves become long and narrow and this disorder is known as 'Whip tail' in Cauliflower.

ii. Radish

Symptoms

Pale yellow leaves, wilting of leaves with onward crinkling.

iii. Tomato

Symptoms

Interveinal chlorosis, inward crinkling of leaves.

Remedial measures

Spray 625 g Ammonium molybdate in 400 lit of water as foliar spray before flowering.

7. Chlorine

1. Leaves chlorotic and susceptible to wilting.
2. Deficiency is practically non-existent in nature because even rain water will carry sufficient Chlorine to provide the required amounts.

Correction

Add Chlorine compound salts to soil.

8. Silicon

1. Wilting growth habit may result.
2. Abnormal accumulation of Fe + Mn may cause necrotic spots.
3. Plants become susceptible to diseases.

Correction

Apply Silicon salts to soil.

Foliar application

The deficiency of micronutrients can be corrected by either soil or foliar application. Since soil application is often encountered with the problems such as fixation, leaching, inabsorbtion and antagonism, foliar application has been a standard practice of application of micronutrients to plants. Spraying also overcomes the problem of immobility of certain metallic ions inside the plant system.

Since the micronutrients are needed in very small quantity, the spray solution employed for foliar application is normally in terms of parts per million (ppm) and the chemical to be so employed is to be in neutralised form, or else scorching of leaves may occur or may prove toxic to plant system.

1) Employ right micronutrients in right concentration by consulting the extension workers or expert.
2) Mixing two or more micronutrients to be ensured only after proper consultation.
3) Take up spray preferably to young expanding foliage to ensure effective absorption. Old leaves absorb very little or nil.
4) Saline and alkaline water should not be employed for preparing micronutrient spray solution.
5) Pour the spray solution through fine filters or muslin cloth to prevent clogging of nozzle.
6) Ensure fine mist of spray evenly on both surfaces of leaves.
7) Avoid spraying during blossom period.
8) Spray preferably during morning or evening.
9) Do not mix plant protection chemicals or Urea with micronutrients.
10) Wash and clean the sprayer, nozzle with clean water after spraying to avoid corrosion and clogging.

Part X

Mushroom Cultivation

Mushrooms are well known for their delicacy and flavour. They are also a good source of nutrition with high quality protein considered superior to vegetable. There are several edible mushrooms cultivated on commercial scale in different parts of the world particularly in USA, France, China, The Netherlands, UK, South Korea, etc. At present world mushroom production is estimated to be about 4 million tonnes per annum whereas in India it is hardly about 15,000 tonnes per annum.

Tamil Nadu with its diversified agroclimate and availability of Agricultural/Horticultural wastes in abundance is most suited for the cultivation of temperate, sub-tropical and tropical mushrooms viz.,

i)	White button mushrooms	*Agaricus bisporus, A. bitorquis*
ii)	Oyster mushrooms	*Pleurotus sajar caju*
		P. citrinopileatus (Co.1)
		P. djamor (MDU1)
		P. ostreatus (Ooty.1)
		P. eous (APK.1)
		P. florida
		P. platypas
iii)	Paddy straw mushroom	*Volvariella diplasia*
iv)	Milky mushroom	*Calocybe indica* (APK.2)

The Oyster mushrooms and milky mushrooms can be grown in plains almost through the year. But, the white button mushrooms can be grown only in temperate climate preferably in hills. Paddy straw mushroom can be grown only during summer months (April – July).

Mushrooms are highly proteinaceous and tastes good. It is used for preparing soups and curries. Though more expensive than vegetables, it is preferred by some people as delicacy. It is very simple to grow, but care has to be taken to maintain hygiene in the growing place, since the contamination can ruin mushroom.

Raw materials

The spawn (seeds) has to be obtained from Plant-pathological laboratories where they are grown under strict laboratory conditions. Rice straw, Polythene bags, Antiseptic solution, and Iron rod with hook on one end, sand and water.

Market potential

This foodstuff is yet to be popular in the rural areas. This is due to

i) High price

ii) Reluctance to new food habits.

However, it has heavy demand in urban areas. It can also be dried and it regains shape on soaking in water. This is a big advantage as it can be marketed in big cities far away from the place of production.

Popularising mushroom cultivation and consumption in rural areas will greatly help in increasing the income and serve as a source of nutrition and improving the economic condition of the rural and urban people. It may also generate employment in several areas.

The targetted markets for mushrooms are

i) Hotels catering to high class society

ii) Supermarkets in bigger cities

iii) Vegetable vendors

iv) Mobile catering units

Cultivation of Oyster mushroom

Varieties

Co 1, MDU.1, APK.1, M2 and *Pleurotus florida.*

Life Cycle Period

40 – 45 days.

Production House

A thatched shed or room, preferably with optimum relative humidity of 80 – 95 % and room temperature of 24°C –28°C with diffused light and ventilation is required. It does not make growth in places where the temperature goes below 24°C. Hence, it is not suitable for cold latitudes and high elevations. The room should be kept cool by hanging gunny screens with periodical sprinkling water on the gunnies. Sand must be spread on the floor upto 2 – 3 cm and be kept moist.

Substrate

Dried Paddy straw @ 500 g per bed can be used as a substrate. Sugarcane trash, cotton waste, paper waste etc. also can be used.

Spawn requirement

One bottle containing 300 gm of spawn is required for two beds of straw. This can be obtained from selected Agricultural Research Stations and in Agricultural Universities.

Preparation of Bed

Take polythene bags of 30 cm diameter, 60 cm height and 70 - 100 gauge thickness. It is preferable to provide two vent holes of 1 cm diameter each in the middle of the bag at opposite directions. Chop paddy straw into small bits of 3 - 5 cm and soak in cold water for 2 - 3 hours. Then immerse in boiling water for 15 - 30 minutes, or steam sterilise it for 30 minutes under 15 psi pressure and drain off excess water from the straw. Shade dry for two hours until to reach 60 – 65% moisture and then use. Remove the spawn from the bottle using a small iron rod with hook on one side. Dip the iron rod in antiseptic solution before use.

Separate the spawn into two lots. Tie the bottom end of the polythene bag with country thread and fill first layer with straw bits upto 5 cm height in the bottom. Then sprinkle a handful of spawn over with entire surface of the straw layer. Add a second layer with straw upto 10 cm height and sprinkle spwan as done before. Similarly from the third and fourth layer of straw bits and repeat spawning. Then fill the top fifth layer with straw bits upto 5 cm height spread and tie the upper end of the polythene bag also with jute twines.

Spawn running

Allow it for spawn running for 15 days. Keep it preferably in dark till mycelial growth appears. Observe periodically and discard contaminated beds having black or green mould growth. Spawn running will be completed within 15 – 18 days.

Cropping

After spawn running buds will appear in beds and continue for about two to three days. During this period maintain temperature (20-28°C) and 75% humidity by spraying water on sand floor and in gunny cloth. First harvest will be ready on 18 – 21 days. After first harvest remove polythene cover and scrap out paddy straw approximately to a depth of 1 cm and spray water or keep moisture always 60 - 65% in beds. Second harvest may develop after one week. Totally four harvest can be taken from one bed within 40 – 45 days period.

Pest

Phorid flies.

Control measures

- Instal multi dimensional (sticky) trap to attract the phorid flies.
- Regularly remove the casing and the waste materials and put it in a compost pit and convert them into manure.
- Fix nylon net of 35 or > 35 mesh in the mushroom house to prevent the entry of flies.
- Spray Chlorpyriphos 20 EC 50 PPM in the compost pit and 25 PPM in casing to control the maggot.
- Spray Dichlorvos 76 WSC 30 ml/100 m^3 over the mushroom house, casings, walls and windows. *Avoid direct spray over the bed.*

Harvest

Pick up the buds after 48 hours of spraying.

Yield

The total yield is 500 – 700 grams of mushroom per bed depending upon spawn, substrate quality and climatic conditions.

Cost of cultivation (in Rs.)

1.	Cost of shed with racks	4,200
2.	Chaff cutter (fabricated)	2,500
3.	Sprayer	1,400
Total		**8,100**

Recurring expenses for 3 months (in Rs.)

1.	Paddy straw	@ 4/kg	1 kg per day	360
2.	Cost of spawn	@ 4/bottle	1 bottle/day	360
3.	Polythene bags	@ 55/kg	10 kg	550
4.	Packing			250
5.	Fungicides			100
6.	Electricity & Miscellaneous			200
Total				**1,820**

Total investment (in Rs.)

1.	Fixed	8,100
2.	Recurring	1,820
	Total	**9,920**

Cost of production (in Rs.)

1.	Recurring expenditure for 9 months	5,460
2.	Depreciation @ 10 % per year	810
3.	Interest @ 12.5 % on working capital	230
4.	Interest on term loan @ 12.5 %	1,010
	Total	**7,510**

Revenue (in Rs.)

1.	7 crops @ 150 kg per crop - 1050 kg @ Rs.30.00	31,500
2.	Profit	23,990

Percentage of profit on sales – 76.00 %

Part XI

Season of Flowering and Fruiting of Fruit Crops

Crop	Season of flowering	Season of fruiting
Mango		
Main season	November - December	April - June
Off season	August - September	January - February
Lime	October - November	January - March
Mandarin	July - August	November - December
Grapes	February - March June - July	April - May August - September
Papaya	Throughout the year	Throughout the year
Sapota	i. June - August ii. October - December iii. March	i. October - December ii. February - April iii. July
Guava	i. April - May ii. July - August iii. October - December	i. August - September ii. November - December iii. January - March
Pineapple	September - October	March - June
Jack		
Main seasons	September - October	March - June
Off season	May - June	October - December
Pomegranate	May - July	October - January
Custard apple	May - June	September - November
Ber	June - July	October - November

Crop	Season of flowering	Season of fruiting
Indian Gooseberry	i. July - August ii. February - March	January - February August - September
Jamun	March - April	August - September
Wood apple	May - June	January - March
Bael	May - June	April - May
Tamarind	September - October	March - April
Karonda	February - March	May - June
West Indian Cherry	August - September	December - January
Mangosteen	January - March	June - August
Passion fruit	i. February - March ii. June - July	June - July September - October
Carambola	i. April - May ii. July - August iii. September - October	July - September November - December January - February
Rambutan	February - March	June - August
Durian	December - January	May - September
Avocado	January - March	May - September
Fig	i. October - November ii. February - March	February - June July - September
Apple	February - March	May - July
Pear	February - March	June - September
Plum	February - March	May - June
Peach	January - February	May – June

Chemical and Commercial Names of Insecticides and Nematicides

CHEMICAL NAME	COMMERCIAL NAME
1. Chlorinated hydrocarbons	
Dicofol (T.A)	Acarin, Banmite, Childion, Decofol, Delcofil, Delcofol, Dicofol Protex, Fumite Dicofol Smoke, Hexabel, Hilfol, Kelthane, Micothane, Mitigan, Tagfol, Vikofol, Ticofol.
Endosulfan (I)	Agrisullfan, Agrosulfan, Bangusulfan, Cacosulfan, Cilosulfan, Demecor, Endocel, Endocel Technical, Endochith, Endocid, Endohit, Endomil, Endosol, Endostar, Endosulfan, Endosun, Endotaf, Enfan, Ensocrop, Ensosulfan, Entacid, Fisulfan, Gayadan, Gilmore Endosulfan, Hexasulfan, Hildan, Hockley - Endosulfan, Hysulphan, Kemsulfan, Kilexanti Sulpass, Krishiendosulfan, Lusulfan, Marvel, Micosulphan, Micothanesulfan, Parasulfan, Parry sulfan, Pesticel, Ramfan Sicosulfan, Solasulfan, Sujadane, Sulfan, Tagsulfan, Thiodan, Thiokill, Thionel, Thionex, Thiotex, Vegfro, Vikasulfan.
Lindane (I)	Agrodone, Canon, Castaway Plus, Enhance plus, Gamma BHC, Gammaxane, Germate plus, Gustafson, ICA, Kondane, Lindafor, Lindalin, Lindane, Lindanex-750 SC, Lindasun EC, Lindex-Plus FS seed Treatment, Lindon, Lindone, Lin sulpn, Marsoline, Micodane, Paraban, Rasayan, Trimisem Total, Wireworm FS seed Treatment.
2. Organophosphates	
Acephate (I)	Acefate, Acemil, Acephate, Agrophate, Aimthene, Asataf, Kayphate, Lancer, Orthene, Ortran, Ortril, Pilarthene, Starthene, Surpass, Tomado, Trophy, Vital.
Chlorpyriphos (I)	Agrofos, Atlas Sheriff, Banusban, Chlorpyrifos, Chlorofos, Classic, Corobon, Crossfire, Danusban, Detmol, Detmolin, Dimlor, Drexar Lawn Granules, Durmet, Dursban, Empire, Fullback, Gilmore Chlorpyrifos, Gilphos, Gladiator, Gustafson, Lorsban 30 Flowable, Gustafson Lorsban 50-SL, Hexaban, Hockley Chlorpyrifos, Hyban, Lethal, Lorsban-T, Point Chlorpyrifos, Predator, Prentox Residual

	Concentrate DV - One, Pychlorex, Pyrenone, Dursban Dual Use, Pyriban, Pyrinex, Radar, Ruban, Salut, Saluthion, Schwab EX, Spannit, Spannit Granules, Suban, Sulban 20, Talon, Terminate, Terragourd 48 EC, Terraguard Plus, Twin span.
Dichlorvos (I-A)	Agrovan-76, Bangvos, Bargros, DDVP, Denkavepon DDVP Ec, Denkavepon DDVP-Technical, Detia Degesh Insect Strip Dichlorvos, Divipan, Divisol, Hockley, Dichlorvos, Lurectron U5, Luvan, Mafu, Mawax Super 100, Nukem 776, Nuvan, Nuvanex, Nuvasul, Paradeep, Piran, Prentox, Schwab EX Sprigone, Spritex, Spritex Super, Unifos 50 EC, Vapona.
Dimethoate (I-A)	Agrodimet-30, Agromat, Ablas Dimethoate 40, Atlas Sheriff, Champ, Clinex, Cifor, Carothiate, Cropgor, Cygon, Demecor, Devigon, Diemoth, Dimer, Dimethoate, Dimex, Entegor, Facron S, Hexaben, Hexagor, Hilthoate, Hockley Dimethoate, Hygro, Kemithoate, Kilxdimethoate, Kiltex, Maktion, Micor, Milgor, MTM Dimethoate, Murphy Systemic insecticide, Pamir, Paragor, Parrydimate, Perfektion, Rasayanate, Rogor, Roxion, Salut, Salution, Sicothate, Sulgor, Tagor, Tara 909, Teletox, Trimetox, Unigor, utkal Dimethoate, Vikagor.
Disulfoton (I-A)	Disyston, Di-Syston, Frumin AL, Hockley Disulphoton, Knave, Mocap plus, MTM Disulfoton, Solvirex, Twin span.
Ethion (I-A)	Demite, Dhanumit, Ethion, Ethisol, Fosmite, Fleathion, Force, Fosmite, Gilmore, Ethion, Lazor, Miti cil, MIT 505, Novathion, Raythion, Rhodocide, Rothion, RP-Thion, Tafathion, Tegithion, Gegfru fosmite, Volthion EC.
Fenitrothion (I-A)	Accothion, Agrothion, Anthiomix, Demise, Detmol, Dicofen, Domeel, Domexil, Durakil, EC-Kill, Fenitox, Fenitrogard, Fenitrogil-50, Fenitrothion, Fethiol, Folithion, Gilmore Fenitrothion, Hexafen, Hockley Fenitrothion, Rentokil insecticides, Sandothion, Schwab EX, Sumithion Turbair Grain store insecticide, Utkal Fenitrothion.
Fenthion (I-A)	Baycid, Baytex, Fensun EC, Fenthion, Lebaycid, Pilartex, Qweletox.
Formothion (I-A)	Anthio, Anthiomix, Sandothion.
Malathion (I)	Agrofmal, Agromala, Bangmal, Bugtax, Chemathion, Corothion, Cythion, Emmaton, Entomol, Gilmore, Malathion Hilthion, Hockley Malthion, Karlophos, Kathion, KP Malathion, Krishi Malathion, Malahi-90, Malamar, Malathion, Malathion Sandoz 50, Malaspray, Malasun EC, Malaone, Malathiozol Malathion, Maltox, Murphy Liquid Malathion, Murphy Malathion Dust, Prentox 51b Malathion spray, Ramathion, SVL Malathion, Taimal.

Methyl Demeton (I-A)	Hexasystox, Himax, Knockout, Metasystox, Parasystox.
Methyl Parathion (I-A)	Agrimethyl, Agropara, Agrotex, Corocid, Devithion, Dhanumar, Ekatox, Entocid, Folidol M, Folidox, Folivim, Kagrodal, Kempar, Kildet, Kilex, Kilsek, Kiofos, Klophos, Luthion, Milon, Metacid, Metapar, Methylparathion, Metpar-760, M.Devithion, Paracrop, Paradol, Parahit, Paramar, Paramet, Paramid, Parasul, Parataf, Parathion, Parathol, Paratox, Ramcidd, ramthion, Tagpar, Vegfro, Vicomethyl, Vikacid.
Monocrotophos (I-A)	Agromonarc, Aimocron, Azodrin, Agrocron, Agromohare, Balvanotophos, Balwan, Corophos, Croton, Entofos, Faptopos, Gilmore Monocrotophos, Glorephos, Gyphos, Hexaphos, Hilcron Hycrophos, Indophos, Kadett, Kagrophos, Kileximonocrotophos, Luphos, Macrophos, Micophos, Milphos, Mondhit, Monitar, Monocid, Monocil, Monocos, Monocron, Monocrotophos, Monodrin, Monogil, Monokem, Monophos 40, Monosect, Monosil, Monostar, Monovol SL, Mostyn Monocrotophos, Nuvacron, Paracron, Parryfos, Phoskill, Pilardin, Ramphos, rasayanaphos, satur, Sicocil, Sufos, Syeperetophos, Triphos, Vegfrokadett, Vimonofos, Viphos.
Phenamiphos (N)	Nemacur.
Phorate (I, N, A)	Aelmet, Agrophorate, Cifphorate, Dragnet, Forate-10 G, Foratox, Fortan, Fortox, Glorate, Granutox, Grenade, Hockley Phorate, Kamet, Krishi Kaymet, Luphate, Milate MTM Phorate, Phorate, Phorate GR, Phorate Technical, Phoride, Starphor-10 G, Starphos, Thimet, Vegfro, Volphor.
Phosalone (I-A)	Agrosalone, Gilmore Phosalone, Micozons, Phosal, Phosalone, Phosalone Technical, Sugalone, Zolone.
Phosphamidon (I-A)	Agromidon, Agrophos, Bangdon, Cildon, Daron, Dimecron, Entocron, Kilrodon, Phamidon, Phoskil, Phosphamidon, Phosron, Pilacron, Sicomidon, Sudon, Sumidon, Vimidon.
Quinalphos (I)	Agriphos, Agroquin, Agroquinal, Award, Bayrusil, Desalux, Dhanufux, Ekalux, Entolux, Gilquin, Hilguin, H-LX, HLX-35, Hockley Quinalphos, Hyquin, Kemlox, Keterphos, Kilex Quinalphos, Kinalux, Knave, Milux, Pharulux, Quinal, Quinalphos, Quinaltaf, Quinatox, Ramlux, Savall, Sicophos, Solux, Starbrand, Suquin, Tagquin, Tombel, Vazra.
Triazosphos (I-A)	Deltaphos, Hostathion.

3. Carbamates

Aldicarb (I, N, A)	Temik, Aldicarb.
Carbaryl (I)	Agrovin, Agroyl, Bangwin, Carbamate, Carbamine, Carbaryl, Carvin, Carvint, Corovin, Devicarb, Hexavin, Hockley Carbaryl, Kervin, Kildiryl, Kilexcarbaryl, Limite, Murphy Lawn Pest Killer, Ravyon, Ryltex, Sevidol, Sevimol, Sevin, Twister Flow.
Carbofuran (I, N, A)	Aimco, Furacarb, carbodan, carbofuran, Curaterr, Diafuran, Furadan, Furasun GR, Hexafuran, Nex, Pilarfuran, Vegfrodiafuran, Yaltox.

4. Insect growth regulators

Diflubenzuron	Dimilin, Empire.
Teflubenzuron	CME 134, Dart, Diaract, Nomolt.

5. Miscellaneous Compounds

Aluminium Phosphide	Al-phos, Aluminium Phosphide, Alutal, Celphos, Detia Bag
(I, F, R)	Blanket, Detia gas, Hockley Aluminium Phosphide, Phos Tek, Phostoxin, Phostoxin T/P, Quickphos.
Bromadiolone (R)	Bromadiolone, Bromadiolone R, Bromapoint Technical Contrac, Contrax, Deadline, Deita, Degesch Ratron Bait Block, Hawk, Hawk Block, Hawk Chunx, Lunirat, Maus EX, Mostyn Bromadiolone, Mushmush, Roban, Rodentox BB.
Cartap hydrochloride	
(1)	Cartap, Padan, Thiobel, Vegetox.
Sulphur (1, A, F)	Atlas Bolda FL, Bolda FL, Cosan/Elosal, Devisulfan, Fluidosoufre, Green Sulphur, Headland Sulphur, Hexsasul, Imber, Kenkol 400 SC, Kombat S, Kumulan, Kumulus DF, Microsol, Microsul, Microthiol Special, Murphy Mole Smokes, Pennsuc S, Saulfat, Suffa, Sulfex, Sulfur 800 SC, Sulfur 900 SC, Sulphotox, Sulphur, Sultron, That Big 8, That Flowable Sulphur, Thiolux, Thiovit, Top Cop, Wacker 83, Wettable Powder and Flowable Sulphur, Wetsul, Wetsulf, Yellow Sulphur.
Warfarin (R)	Biotrol, Co-Rax, Co-R-Tox, Cumarax, Dethmor, Dethnel, Final Pelleted Rat and Mouse Bait, Hockley Warfarin, Kypfarin, Liqua-Tox, Mar-Frin, Ragumin, Ratorax RAX, Rodex, Rodentox BB, Rosex, Rotafin, Rotafrin, Sakarat Ready to use, Sewarin Extra,

	Sewarin P, Sewercide, Solfarin, Sorexa, Tox-Hid, Unicrop Warfarin Warf, Warfarat, Warfarin.
Zinc Phosphide (R)	Denkarin grains, Gopha-Rid, Hockley Zinc Phosphide, Mole and Gopher Bait, Phosvin, Pollux, Ratol, Ridall, Rodenticide AG, Rodent Pellets, Zinc Phosphide, Zinc Tox ZP.

6. Neem products

Azadirachtin (I)	Bioneem, Econeem, Godrej Achook, Margocide CK 20 EC, Margocide CK 80 EC, Neemark, Neemazal F, Neemazal T/S, Nimbecidine, Neem Gold, Nimbasol, Rakshak, RD-9, Ropellin 93 EC, Sukrina.
Neem Oil (I)	Biosol, Juerken, Kemissal, Margosal, Neem plus, Neemguard, Neem pure, Phytowin, TNAU Neem.
Neem Kernel (I)	Ecomak, Neemax, Neemactin, Neemicide.

7. Biocide

Bacillus thuringiensis	
(I)	Agree Bioasp, Biohelp, Biotex, Ceratan, Delfin, Dipel, Halt, Javelin, Lupin, Spicturin, Teknar, Thuricide, Trident, Turex.

A - Acaricide, F - Fumigant, I - Insecticide, N - Nematicide, R - Rodenticide

Chemical and Commercial Names of Fungicides

1. Copper Sulphate preparations

Bordeaux mixture	It is prepared by mixing Copper Sulphate and lime in water (To get 1 % mixture, mix 1 kg of $CuSO_4$ and 1 kg of lime in 100 litres of water.
Bordeaux paste	It is prepared by mixing 1 kg of $CuSO_4$ and 1 kg of lime in 10 litres of water.
Burgundy mixture	It is prepared by mixing of 1 kg of $CuSO_4$ and 1 kg of Sodium Carbonate in 100 litres of water. Burcop, Taytox.
Cheshunt compound	It is prepared by mixing 2 parts of Copper sulphate and 11 parts of Ammonium Carbonate.

2. *Organomercurials*

Methoxy ethyl mercury chloride, Agallol, Aretan, Emisan, Ceresan, Wet (India) Chloride.

Phenyl mercury chloride, Cceresan Dry (India), Ceresol, Leytosan.

3. Inorganic Sulphur

Elemental Sulphur

a. Sulphur dust Sulphur dust.

b. Wettable Sulphur Cosan, Wetsulf, Microsul. Microsul 80 % Thiovit, Thiosulf, Sulfex, Sulphux.

4. Organic Sulphur (Dithiocarbamates)

Ziram	Cuman L, Ziram, Ziride 80 WDP, Hexazir 80% WP, Corozate, Fuklasin, Karbamwhite, Milbam, Vancide 51Z, Zerlate, Ziram, Zirberk, Zitox 80 % WDP.

Ferbam	Coromet, Ferbam, Ferberk, Fermate, Fermate D, Fermocide, Hexaferb 75% WP, Karbam black, Ferradow.
Thiram (TMTD, Thiuram)	Thiride 75 WDP, Thiride 750, Thiram 75 % WDP, Hexathir, Normersan, Panoram 75, Thiram, TMTD, Arasan, Tersan 75, Thylate, Pomarsol.
Zineb	Hexathane 75 % WP, Dithane Z 78, Funjeb, Lonocol, Parzate C, Du Pant fungicide A, Polyram.
Mancozeb (Maneb + Zinc ion)	Dithane M 45, Indofil M 45, Manzeb
Vapam	Vapam, VPM, Chemvape, 4-S, Karbation, Vita Fume.

5. Heterocyclic Nitrogen Compounds

Captan	Captan 50 W, Captan 75 W, Essofungicide 406, Orthocide 406, Vancide 89, Deltan, Merpan, Hexacap.
Captafol	Foltaf, Difoltan, Difosan, Captaspor, Folcid, Sanspor.

6. Systemic fungicides

Carbendazim (MBC)	Bavistin 50 WP, MBC, Derosol B.sten 50, Zoom, Tagstin, Lignasan, Agrozim, Jkestin.
Thiophanate	Topsin 50 WP, Cercobin 50WP, Enovit
Thiophanatemethyl	Topsin-M 70WP, Cercobin-M 70 WP, Enovit-Methyl, Mildothane
Carboxin(DCMO)	Vitavax 10% D, Vitavax 75% WP,Vitavax 34% liq. Vitaflow.
Oxycarboxin(DCMOD)	Plant vax 5G, Plantvax 5% liq. Plantvax 12.5 EC, 10% dust, 75 WP
Tridemorph	Calixin 75 EC, Bardew, Beacon
Triadimefon	Bayleton, Amiral
Metalaxyl	Apron 35 SD
Metalaxyl + Mancozeb	Ridomil Mz 72 WP
Fosetyl Al. (Aluminium-Tris)	Aliette 80 WP

Tricyclazole	Beam
Hexaconazole	Contaf 5 EC
Propiconazole	Tilt 25 EC
Penconazole	Topax 10 EC

7. Miscellaneous Fungicides

Dinocap	Karathane, Arathane, DNOPC, Mildex, Crotothane, Crotothane 25%, Crotothane 48% Liq.
Chinomethionat (Oxythioquinox)	Morestan 25% WP, Morestan 2% D
Quintozene (PCNB)	Brassicol, Terraclor, Tritisan 10%, 20% 40%D, and 75% WP, PCNB 75% WP
Fenaminsosulph	Dexon 5% G and 70% WP
Ediphenphos (Edifenphos, EDPP)	Hinosan 50% EC and 2% D
Chlorothalonil	Kavach 75WP, Bravo, Daconil, Termil, Chlorothalonil 40SC Safeguard, Spektrum
Fentin hydroxide(TPTH)	Du-Ter WP 20% or 50% WP, Du-Ter Extra-WP Farmatin 50 WP, Du-Ter forte WP, Tubotin.
Fentin acetate(TPTA)	Brestean WP 40% and 60% WP

8. Antibiotics:

Streptomycin +	Agrimycin-100, Streptomycin, Agristrep, Embamycin
Oxyetracycline (Terramycin)	Phytomycin, Phytistrep.
Streptomycin + Tetracycline Hydrochloride	Streptocycline, Paushamycin
Aureofungin	Aureofungin-sol
Cycloheximide	Actidione, Actidione PM

Part XIV

Weed Management and Herbicides Usage in Horticultural Crops

Weed management has become an integral part of Agriculture. There is little doubt that with the progressive modernisation of Indian Agriculture involving intensive inputs, herbicide use will steadily gain an importance in the coming years. In the recent decades, the growth of herbicides took place principally at the expense of fungicides, which declined from a market share of 40 per cent in 1960 to 25 per cent in 1995. About 72 per cent of the herbicide consumption out of the total took place in the developed countries, viz., USA, Western Europe and Japan. As against the growth of 2.5 per cent for insecticides and 3.3 per cent for fungicides, the herbicides grew at the rate of 5.0 per cent per annum.

In India, commercial use of herbicides came in 1980. During the period, the herbicides registered a significant growth than insecticides and fungicides. From a mere 2 per cent share of the total pesticide consumption in the seventies in India, herbicides now account for about 11 per cent of the pesticides market. While this is a very encouraging development, the herbicide consumption in our country is still much less than that in developed countries, where herbicides constitute 40-50 per cent of the total pesticide consumption.

Conjunctive use approach:

There are several advantages of using soil applied herbicides in conjuction with fertilizers. Trials on impregnated of fertilizers with herbicides have been highly successful and fertilizers impregnated with several herbicides are now commercially available in USA. Herbicides like Treflan, Sutan, Sencor and Bladox are being efficiently used through this technique. Adequate research efforts need to be undertaken in this regard to develop appropriate technology for the different agroclimatic conditions including herbigation.

System approach:

Integrated weed management (IWM) practices for individual crops have been developed by several workers. There is a need to study the various components of IWM into a systems approach.

Integrated weed management system

This approach includes the use of high yielding varieties that resist weed competition and reduce the weed-seed reserve in the soil. Practices like preplanting seed bed tillage, effective seed-bed preparation and seeding methods enhance crop growth and minimise weed growth. The use of crops that form early canopy with optimum plant population are integrated to optimize the crop growth and thus to minimise the weed growth. Precision in placement and timing of fertilizer application maximise stimulation of crops and minimise stimulation of weeds. The IWM system also

includes the use of judicious irrigation practices, timely and appropriate cultivation, sound crop rotation, crop diversification, field sanitation and harvesting methods that do not spread weed seeds, use of biological agents and effective chemical methods. However, the crop-weed interactions are complex and needs application of recent advancements for the development of future weed management strategies.

Crop-weed competition

Experimental results have shown that crop-weed competition at critical stages of crop life has reduced the yields in several crops. Often this period is approximately the first one fourth to one third of crop like for annual vegetables and for perennials flowering to maturity periods. Estimation of crop-weed interactions through mathematical models is being attempted.

Modelling of crop-weed interactions

Competition between crop and weed for growth inputs (light, water and nutrients) is a critical process in agricultural ecosystems. The mechanisms of competition are not simple. Models on weed invasion, population growth and control will be useful for organizing biological informations on weeds and for developing weed control strategies. Conventional field trials cannot answer several of the key questions in weed control because of the constraints of cost, time or complexity. Hence models are essential as an integral part of weed management research and advice.

Bio-herbicide approach

Fungi are most useful and hence the term 'mycoherbicide' is also used to refer bio-herbicides. 'De vine' containing a formulation of soil borne fungus *Phytophthora palmivora* and Collego containing spores of *Colletrotrichum gloeosphorioides* an endemic anthrocnose fungus are commercialised bio-herbicides. Other fungal bio-herbicides have been developed including 'Velgo' based on *Fusarium leteriteum* and 'Casst', which is based on *Alternaria cassiae*.

Naturally occurring herbicides

Many chemicals have been found to possess good herbicidal activity. 'Bialophos' is the first herbicide developed by this method and commercially marketed in Japan under the trade name 'Herbiace' isolated from fermentation broths of *Streptomyces aygroscopius* and *S. viridochromogens* enhibits acidity against wide spectrum of grasses and broad leaved weeds on foliar application.

I. FRUITS

Grapes

Application of Diuron @ 3.5 kg/ha or Glyphosate @ 2 kg/ha.

Herbicide application in grapevines must be done carefully with low pressure nozzle to prevent drift.

Banana

Pre-emergence application of Atrazine or Simazine or Diuron at 1.5 to 2 kg/ha soon after

planting would keep the ground weed free for 3 to 5 months. At post emergence, Paraquat or Dalapon or 2,4 – D or Glyphosate can be used.

Pineapple

Pre-emergence herbicides like Simazine or Atrazine or Diuron 3 to 4 kg/ha application 4 – 6 weeks before planting and ploughing the field 2 weeks before the leaves of the crop began to curled down to prevent weed establishment. Weed growth emerging later is treated with post emergence herbicides such as PCP 3 to 5 kg/ha or Glyphosate 0.5 kg/ha or Dalopon 3 to 4 kg/ha or 2,4 – D 0.5 to 1 kg/ha depending upon the predominant weed species. Dalapan spray drift can cause chlorosis on outer leaves and necrosis on leaf tips when pineapple plants are young. It should be applied carefully any time from 6 months.

II. VEGETABLES

Tomato

In Tamil Nadu tomatoes are being grown in three seasons namely June-July, December-January and March.

The critical period of weed competition in tomato is the first 30 days after transplanting. For the control of annual grasses, preplanting soil incorporation of Trifluralin 3 to 5 kg/ha or Nitralin 3 to 5 kg/ha or Diphenamid 2 to 4 kg/ha is best. Similar application of EPTC 2 to 3 kg/ha controls nutgrass. Effective pre emergence herbicides are Alachlor 1 to 2 kg/ha Metribuzin 1 to 2 kg/ha, Fluchloralin 0.75 to 1.5 kg/ha, Nitrofen 1.5 to 2.5 kg/ha Chloramben 2 to 3 kg/ha. Generally, a pre emergence herbicide followed by one hand weeding in the later period of crop growth gives complete weed control.

Herbicides which need preplant incorporation are particularly useful in the nursery. In the transplanted field they are applied 3 to 4 weeks before planting seedlings.

Brinjal

Fluchoralin @ 1.5 kg/ha as pre sowing incorporated spray + one Hand weeding at 6 weeks after transplanting or Pre emergence Metolachlor @ 1 kg/ha at 3 days after transplanting followed by 1 hand weeding at 60 days after transplanting.

Onion

Onion germinates and grows relatively slow and hence weed competition is more critical upto 40 days after sowing. Pendimethalin @ 1.5 kg/ha or Fluchloralin 1.0 kg/ha or Oxyflourfen 0.25 kg/ha followed by one hand weeding at 45 days after sowing.

Chillies

Pre-emergence application of Pendimethalin 1.25 kg/ha or Butachlor @ 1.0 kg/ha supplemented with one hand hoeing at 30 days after transplanting.

Bhendi

The most critical period of weed competition in bhendi is between 30 and 60 days after sowing.

Pre-emergence herbicides Metolachlor 0.75 kg a.i./ha, Alachlor 1 to 1.5 kg/ha, Nitrofen 0.5 to 1 kg/ha, Fluchloralin 0.5 to 1 kg/ha followed by one hand weeding 6 to 8 weeks after sowing.

Cole crops (Cabbage and Cauliflower)

Either Fluchloralin @ 0.9 kg/ha or Pendimethalin @ 1.0 kg/ha along with one hand weeding at 40 days after planting.

Carrot

Preplant incorporation of EPTC 3 to 4 kg/ha or Trifluralin 0.5 – 1 kg/ha or pre-emergence Metribuzine at 1.0 kg/ha to control annual weeds.

Beans

The critical period of weed competition is the first 40 days after sowing. Pre-plant incorporation of EPTC 3 to 4 kg/ha or Trifluralin 0.5 to 1 kg/ha or pre-emergence application of Fluchloralin @ 1.0 or 1.5 kg/ha.

Radish

Application of pre-emergence Metolachlor 1.0 – 2.0 kg/ha or Alachlor 1.5 – 2.0 kg/ha or Isoproturon 1.0 – 1.25 kg/ha or Pendimethalin 1.2 kg/ha or Fluchloralin 0.9 – 1.35 kg/ha.

Peas

Pre-emergence application of Alachlor 1 to 2 kg/ha or pre-plant soil application of EPTC 2 to 3 kg/ha.

Dalapan is applied as post emergence when Peas are 5 to 15 cm tall but not within 25 days of harvest. MCPA and MCPB are applied when broad leaved weeds are at 10 to 15 cm tall.

Garlic

Pendimethalin 1.0 kg/ha + one hand weeding at 40 days after sowing.

III. SPICES

Coriander

Pendimethalin at 0.75 kg/ha or Butachlor 1.0 kg/ha supplemented with one hand weeding.

IV. PLANTATION CROPS

Coffee

Single tank mix application of Diuron 1 kg/ha with Paraquat 0.4 kg/ha or Glyphosate 0.8 kg/ha.

In coffee nurseries, apply Simazine 2 to 2.5 kg/ha immediately after planting coffee in polythene sleeves.

At post emergence Paraquat or Dalapan or Glyphosate are used to control many perennial weeds.

Sequential application of Dalapan 1 to 2 weeks later by Paraquat and subsequently by Dalapan controls perennial grasses effectively.

Tea

Although herbicides are now used over 60% of the area under tea, manual methods like cheeling, sickling and mulching are extensively used wherever labour is available than by chemical method. Cheeling removes the above ground weed growth and prepares the ground for pre-emergence herbicide application. Sickling is done to remove the tall growth of perennial weeds and cut it back to the ground level for a follow up application of foliage applied herbicides on the regrowth.

The weed growth emerging later can be eliminated by foliage application of Paraquat + MSMA or 2,4 – D or Paraquat + 2,4 – D or Glyphosate depending on the weed spectrum and this would keep tea weed-free for the rest of the year.

Nursery:

Weed control in clonal nursery is done by (2 to 3 weeks before planting cuttings) application of Simazine at 2 kg/ha. After 6 months Simazine is applied once again at the same dose.

In the case of seed nurseries hand removal is done for 6 months after planting and then Simazine applied at 2 kg/ha.

Young tea (Until 3 years)

Application of Simazine 1.5 to 2 kg/ha or Paraquat 0.3 – 0.4 kg/ha at pre-emergence and 2,4 – D 0.5 to 1 kg/ha at post emergence.

Matured tea (Above 3 years)

Simazine 1.5 to 2 kg/ha or Diuron 2 kg/ha as pre-emergence herbicides. Paraquat or 2,4 – D or Paraquat + MSMA or Glyphosate are applied as post emergence.

Chemical and Commercial Names of Herbicides

Common Name	Trade Name	Time of application
Trifluralin	Hexatox; Toxa-phone	Preplant; pre-em
Nitralin	Planavin	Preplant; pre-em
Diphenamide	Dymid, Enide	Preplant; pre-em
Alachlor	Lasso	Pre-em
Metribuzin	Sencor	Pre-em; Post-em
Fluchloralin	Basalin	Pre-em
Nitrofen	Tok-E 25	Early post; Pre-em
Chloramben	Amiben, Vegiben	Pre-em
Metolachlor	Dual	Pre-em; Early post
Pendimethalin	Procol, Herbadox, Stomp	Pre-plant; Pre-em
Oxyfluorfen	Goal	Pre-em; Post-em
Butachlor	Machete	Pre-em
EPTC	Agrothion, Eptam	Pre-plant; Pre-em
Isoproturon	Arelon, Tolkan	Post-em
Dalapan	Dowpan	Post-em
Diuron	Karmex	Post-em
MSMA	Daconate, Ansar	Post-em
Atrazine	Atrataf	Post-em; Early-post
Simazine	Tafazine / Gesatop	Post-em; Post-em
Paraquat	Gramaxone	Post-em
Glyphosate	Roundup, Glycel	Post-em

Cultural tips for

S. No.	Crops	Varieties	Season	Seed rate grams/ha	Spacing in cm.
1	2	3	4	5	6
1	Brinjal	Arka Navneet, Suphal, Ajay, Vijay, Kirti, Mhb1, Mhb2, Mhb3, Mhb9, Kalpa Tharu, Ravayya	Planted during May – June Oct – Nov Jan – Feb	200	90 x 60
2	Tomato (Determinat e	Mangala, Rajani, Rashmi, Rupali, Sheetal, Vaishali, Hybrid No.10	Planted during March – April Nov – Dec Sep – Dec	175	75 x 45
3	Tomato (Indetermina te)	Karnataka, Naveen, Suruchi, Sangam, Amrut, Cross-B, Sonali, Sadābhakar, Preethi, Gulmohar, S-28, S-29, Morning Sun.	Planted during May – June Oct – Nov Jan – Feb	120 – 150	75 x 60
4	Bhendi	Shobha 110, Shoba 111, Badsha, Hybrid-6, Hybrid-7, Varsha, Vijaya, Vishal	Sown in Feb – March June – July Oct – Nov	15000	60 x 15
5	Cabbage	Hybrid No.10, Hybrid No.20, Indu, Pooja, Namratha, Sumathi, Lakshmi, Iahs-I, Iahs-Ii, Iahs-Iii, Kranthi, Kalyani, Sriganesh Khol, Kaveri, Ganga, Hariranikhol	Planted during May – Feb	300 – 550	60 x 30
6	Cauliflower	Iahs-12, Iahs-18, Snowball, Improved, Swati, Himani, Subarna	Planted during Jan – Feb June – July	300 – 350	60 x 30
7	Capsicum	Barath, Heera, California Wonder, Yolo Wonder, Hybrid No.10, Hybrid No.11, Midway	Planted during June – July Sep – Oct Jan – Feb	375	60 x 30

F-1 hybrid vegetables

Number of plants/ha	Farmyard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
7	8	9	10	11	12	13
18,520	25	200:150:100	200 – 500	150	25	-
29,630	40	200:250:250	80	120	35	Suitable for mechanical harvest, tolerant to *Fusarium* and *Verti cillium* wilt
22,220	40	200:250:250	80 – 200	150 – 165	100 – 110	Tolerant to *Fusarium Verticillium* and Nematode
1,11,110	40	200:100:100	-	90	12 – 15	Tolerant to yellow vein mosaic and powdery mildew.
55,550	25	200:125:150	2000 – 3500 (Head)	105	50 – 75	Heat tolerant (upto 38° C)
55,550	25	200:125:125	500 – 700 (Curd)	105	25 – 30	
55,550	30	250:150:150	100 – 150	165	35 – 40	Tolerant to T.M.V.

S. No.	Crops	Varieties	Season	Seed rate grams/ha	Spacing in cm.
1	2	3	4	5	6
8	Chillies	Sujatha, Surya, MHB-55, MHB-58, MHB-59, Cayennelarge Red Thick, Cayenne Long Slim, Divya, Rathna, Samrat, Prithivi	Planted during June – July Sep – Oct Jan – Feb	200 – 250	75 x 60
9	Watermelon	Madhu, Milan, Mohini, Arka Jyoti, Amruth, MHW-11, Sunthrupthi, MHW-15, MHW-6, Apoorva, Madhuri	Sown in Nov – Jan	1500 – 2750	150 x 30
10	Musk Melon	Swarna, MHC-2, MHC-5, MHC-6, Honeydew, Sona, Earli- Dew, Magnum-45	Sown in Nov – Jan	525 – 800	150 x 30
11	Cucumber	Priya, Bliiz, Lucky Strike, Poinstt-76, Harsha, Calypse,	Sown in Nov – Jan	373	150 x 60
12	Bitter Gourd	Hybrid-49, While Long, Greenlong, MPDH-101, MPDH-102	Sown in June – july	1800	180 x 60
13	Bottle Gourd	Pusa Megdooth, MGH-1, Varath, Hybrid-204	Sown throughout the year. Yield will be more if it is sown during June – July	1800	180 x 60
14	Ribber Gourd	Sureka, MSGH-1, Haritha	Sown in June – July	1800	180 x 60

Number of plants/ha	Farmyard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
7	8	9	10	11	12	13
22,220	30	120:80:80	-	150	13 – 16	Wide adoptability for fresh market high degree uniformity, Latebligh & bacterial leaf spot resistant
22,220	30 – 40	200:100:100	5000 – 8000	90 – 105	100 – 110	Tolerant to *Fusarium* wilt
22,220	30 – 40	200:100:100	800 – 1000	120	25 – 30	Tolerant to *Fusarium* wilt
25	150:75:75	300	90	20 – 25		Tolerant to downy mildew, powdery mildew and mosaic
9,259	25 – 30	200:100:100	100 – 120	90 – 105	60 – 65	Thick flesh with less seeds, attractive colour
9,259	25 – 30	200:100:100	3000 – 5000	90 – 105	45 – 60	Suitable for long distance transport
9,259	25 – 30	250:100:100	125 – 150	105 – 120	40 – 45	Attractive green colour.

Part – XVI

Appendices

Appendix - I

Number of plants per acre

Distance in feet	No.of plants per acre	Distance in feet	No. of plants per acre
1 x 1	43560	12 x 12	302
1½ x 1½	19460	13 x 13	257
2 x 2	10890	14 x 14	222
2½ x 2½	6960	15 x 15	193
3 x 3	4840	16 x 16	170
3½ x 3½	3556	17 x 17	150
4 x 4	2722	18 x 18	134
4½ x 4½	2151	19 x 19	120
5 x 5	1742	20 x 20	108
6 x 6	1210	22 x 22	90
7 x 7	889	24 x 24	75
8 x 8	680	26 x 26	64
9 x 9	537	28 x 28	55
10 x 10	435	30 x 30	48
11 x 11	360	40 x 40	27

1 Acre	=	4840 sq. yard	1 Hec	=	10000 sq.mt.
1 Acre	=	43.560 sq.ft.	1 Hec	=	250 cents
1 Acre	=	40 Guntas	1 Hec	=	2.47 acres
1 Acre	=	4046.80 sq.mt.			

Appendix - II

Number of trees per acre

Spacing(ft)	Square	Quincunx	Hexagonal
10	435	870	500
16	170	340	195
20	109	218	125
24	75	150	86
28	56	112	64
36	34	68	39
40	27	54	31

Appendix - III

Number of plants per acre

Distance in metre	No. of plants per acre
1 x 1	4000
2 x 2	1000
3 x 3	444
4 x 4	250
5 x 5	160
6 x 6	111
7 x 7	81
8 x 8	62
9 x 9	43
10 x 10	40

Appendix - IV

Germination and purity standards

Sl. No.	Variety	Germination minimum percentage	Purity minimum percentage
1	Cowpea	75	98
2	Cluster beans	70	98
3	Field beans	75	98
4	Beans	75	98
5	Ladies finger	65	99
6	Bitter gourd	60	99
7	Sponge gourd	60	99
8	Bottle gourd	60	99
9	Cucumber	60	99
10	Snake gourd	60	99
11	Watermelon	60	99
12	Pumpkin	60	99
13	Cauliflower	65	98
14	Cabbage	70	98
15	Knol-khol	70	98
16	Carrot	60	95
17	Radish	70	98
18	Brinjal	70	98
19	Tomato	70	98
20	Chillies	60	98
21	Capsicum	60	98
22	Greens	70	95
23	Fenugreek	70	98
24	Basella	60	96
25	Onion	70	98

Appendix - V

Viability of Horticultural seeds

Sl. No.	Name of seed	Max. viability period
	A. Vegetables	
1	Onion	6 Months
2	Beans, Pea, Cowpea	1 Year
3	Brinjal, Tomato, Chillies, Capsicum, Cucumber, Squashes, Pumpkin, Carrot, Radish, Turnip, Cole crops.	1.5 Years
4	Bhendi, Lettuce, Amaranthus, Methi, Beet root, Palak.	2 Years
	B. Fruits and root stock plants	
1	Lime, Mandarin, Citrus rootstock species	1 Week
2	Mango stones, Litchi, Passion fruit, Butter fruit, Rose apple, Jambulana.	1 Month
3	Papaya, Kirni seeds	3-4 Months
4	Guava	4 Months
5	Watermelon, Musk melon	1 Year
6	Custard apple, Ramphal and other Annona sp.	1.5 Years
	C. Plantation and Spices	
1	Clove, Nutmeg, Cinnamon, Curryleaf	1 Month
2	Arecanut, Cashewnut	3 Months
3	Coconut	4 Months
4	Coriander and other annual spices	1 Year
	D. Flowers	
1	Aster seeds, Gladioli corms	1 Year
2	Marigold	1.5 Years
3	Other annual flower seeds	1 to 2 years

Appendix VI - Average composition of manures and fertilisers

Materials	Percentage of Nutrients		
	N	P	K
Ammonium sulphate	20.5	-	-
Ammonium sulphate nitrate	26.0	-	-
Ammonium nitrate	33.5	-	-
Ammonium phosphate	16.0	20.0	-
Calcium ammonium nitrate	20.5	-	-
Nitrate of soda	16.5	-	-
Urea	46.0	-	-
Superphosphate-single	-	18.0	-
Superphosphate-double	-	35.0	-
Superphosphate-triple	-	45.0	-
Ultraphos	-	28.3	-
Mussoriephos	-	20-24	-
Rock phosphate	-	28.4	-
Bone meal	3.5	21.0	-
Muriate of Potash	-	-	50 or 60
Poultry manure	1.2 - 1.5	-	-
Sheep manure	0.8 - 1.6	-	-
Farm yard manure	0.4	0.3	0.2
Compost	0.5	0.25	0.5

Appendix VII

Conversion of pure nutrients to various N, P and K fertilisers

Rate of application (kg/ha)	Ammonium sulphate (20% N)	Urea (46% N)	Super phosphate (18% P)	Muriate of potash	
				(50 % K)	(60 % K)
10	50	22	56	20	17
20	100	44	112	40	34
30	150	66	168	60	51
40	200	88	224	80	68
50	250	110	280	100	85
60	300	132	336	120	102
70	350	154	392	140	119
80	400	176	448	160	136
90	450	198	504	180	153
100	500	200	560	200	170
110	550	242	616	220	187
120	600	264	672	240	204
130	650	286	728	260	221
140	700	308	784	280	238
150	750	330	840	300	255

Appendix VIII - Neutralising value of liming materials

Calcium carbonate or lime stone	$CaCO_3$	100
Burnt lime	CaO	179
Staked lime	$[Ca(OH)_2]$	136
Dolomite	$[CaMg(CO_3)_2]$	109

Source: Package of Practices recommendations 'crops' 1993, KAU.

Appendix IX - Schedule for preparation of 10 litre standard spary solution

a.i.	0.02	0.04	0.05	0.06	0.08	0.1	0.2	0.3	0.4	0.5
Quantity of plant protection chemical required to be added to 10 litres of water (in ml or gm)										
20	10	20	25	30	40	50	100	150	200	250
25	8	16	20	24	32	40	80	120	160	200
30	7	13	17	20	27	33	67	100	133	167
35	6	11	14	17	23	29	57	86	114	143
40	5	10	13	15	20	25	50	75	100	125
45	4	9	11	13	18	22	44	67	89	111
50	4	8	10	12	16	20	40	60	80	100
55	4	7	9	10	15	18	36	55	73	90
60	3	7	8	10	13	17	33	50	67	83
65	3	6	8	9	12	15	30	46	62	77
70	3	6	7	9	11	14	29	43	58	71
75	3	6	7	8	11	13	27	40	53	67
80	3	5	6	8	10	13	25	36	50	63
85	2	5	6	7	9	12	24	35	47	59
90	2	4	6	7	9	11	22	35	44	56
95	2	4	5	6	8	11	21	32	42	53
100	2	4	5	6	8	10	20	30	40	50

Source: Horticultural Technical Guide, GOK

Appendix X - Vernacular names of Horticultural Crops

Crop	Scientific name of the crop	Tamil	Telugu	Malayalam	Kannada
Mango	*Mangifera indica* L.	Ma	Mamidi	Manga	Marinna
Guava	*Psidium guajava* L.	Koyya	Jama	Pera	Seba
Pomegranate	*Punica granatum* L.	Madulam	Danimma	Madulam	Dalimbari
Jack	*Artocarpus heterophyllus*	Pala	Panasa	Pilavu	Alasu
Jamun	*Eugenia jambolana*	Naval	Neerudu	Navil	Neredu
Tomato	*Lycopersicon esculentum* Mill.	Thakkali	Seemavanga	Thakkali	Vanga
Bhendi	*Abelmoschus esculentus* L.Moench.	Vendakkai	Bhendakaya	Bhendakayi	Vendakai
Onion	*Allium cepa* var. *aggregatum* L.	Vengayam	Neerulli	Bawanj	Nirulli
Cluster beans	*Cyamopsis tetragonolobus* L.	Kothavarai	Goruchikkudukaya	Kothavarakka	Govardanakayi
Pumpkin	*Cucurbita moschata* Poir.	Poosani	Gummidikaya	Mattanga	Kumblakayi
Ribbed gourd	*Luffa acutangula* Roxb.	Peerkankai	Nunnabheera	Peechinga	Heerekkai
Bitter gourd	*Momordica charantia* L.	Pavakkai	Kakarakaya	Kaipakka	Hagalakkai
Snake gourd	*Trichosanthes anguina* L.	Pudalankai	Potlakaya	Padavalanga	Padivalakkai
Ash gourd	*Benincasa hispida* Cogn.	Kalyanapoosani	Budeethagummidi	Kumbalam	Budikumbla
Bottle gourd	*Lagenaria siceraria* Standl.	Sorakkai	Anapakaya	Churakkai	Soarekkai
Cucumber	*Cicumis sativus* L.	Velliri	Dosakaya	Vellirikkai	Southikadi
Cowpea	*Vigna sinensis* L.Walp.	Karamani	Alasandalu	Kottapairu	Avadai
Lablab	*Lablab purpureus* var.*typicus* L.	Avarai	Chikkudukayalu	Avarakka	Avaraikkai
Potato	*Solanum tuberosum* L.	Urulaikizhangu	Urulaigadda	Urulakizhangu	Urulagadda
Sweet potato	*Ipomoea batatas* L.Lam.	Sakkaraivalli	Genusagaddalu	Chakkaraikizhangu	Genusa
Tapioca	*Manihot esculenta* Crantz.	Maravalli	Karrapandalam	Kappakka	Maragenusa

Elephant yam	*Amorphophallus companulatus* Blume.	Shenaikizhangu	Thiyyakanda	Chenai	Suvarnagadda
Colocasia	*Colocasia esculenta* L.Scott.	Seppankizhangu	Chamagadda	Chembu	Kerugadda
Amaranthus	*Amaranthus* sp.	Keerai	Thotakoora	Cheera	Arivesoppu
Coccinia	*Coccinia indica*	Kovaikkai	Donda	Kovaikkai	Thondikkai
Curryleaf	*Murraya Koenigii*	Karuveppilai	Karepaku	Kariveppillai	Kariberu
Mint	*Mentha sp.*	Pudina	Pudina	Muthina	Pudina
Pepper	*Piper nigrum* L.	Milagu	Mirialu	Kurumulagu	Karimenasu
Nutmeg	*Myristica fragrans* Hoult.	Jathikkai	Jajikaya	Jatikka	Jajikayi
Cinnamon	*Cinnamomum zeylanicum* Blume.	Lavangapattai	Sannalavanga	Erikkolam	Dalacinnicakke
Coriander	*Coriandrum sativum* L.	Kothamalli	Dhaniyalu	Kothumpalari	Kothumpari
Garlic	*Allium sativum* L.	Vellaipoondu	Tellagadda	Vellulli	Bellulli
Tamarind	*Tamarindus indicus* L.	Puli	Chintha	Puli	Hunase
Ginger	*Zingiber officinale* Rosc.	Inji	Allam	Inji	Shunti
Fennel	*Foeniculum vulgare* Mill.	Perunjeeragam	Saompu	Peerunjeeragam	Sompu
Fenugreek	*Trigonella foenum graeum* L.	Venthayam	Menthulu	Uluva	Menthya
Cardamom	*Elettaria cardamomum* Maton.	Yelakkai	Yelakayalu	Elathari	Yelakki
Cumin	*Cuminum cyminum*	Seeragam	Jeelakkara	Jiragam	Jeerigae
Turmeric	*Curcuma domestica* Val.	Manjal	Pasupu	Manjal	Arashina
Mustard	*Brassica juncia* L. Czern. Coss	Kadugu	Avalu	Katuka	Sasive
Clove	*Eugenia caryophyllus* Spregel.	Kirambu	Lavangam	Grambu	Lavanga
Cashew	*Anacardium occidentale* L.	Munthiri	Jeedimamidi	Parangimavu	Geru
Betelvine	*Piper betle*	Vethalai	Tamalapakulu	Vettala	Veeluvadele
Senna	*Cassia augustifolia* Vahl.	Surathnilavakai	Nilathangadu	Sunnamukki	Sunnamukki
Ajowan	*Tracnyspermum ammi* L.	Omum	Vamu	Omum	Oma

தமிழ்நாடு ஆவணக் காப்பகம்
227971
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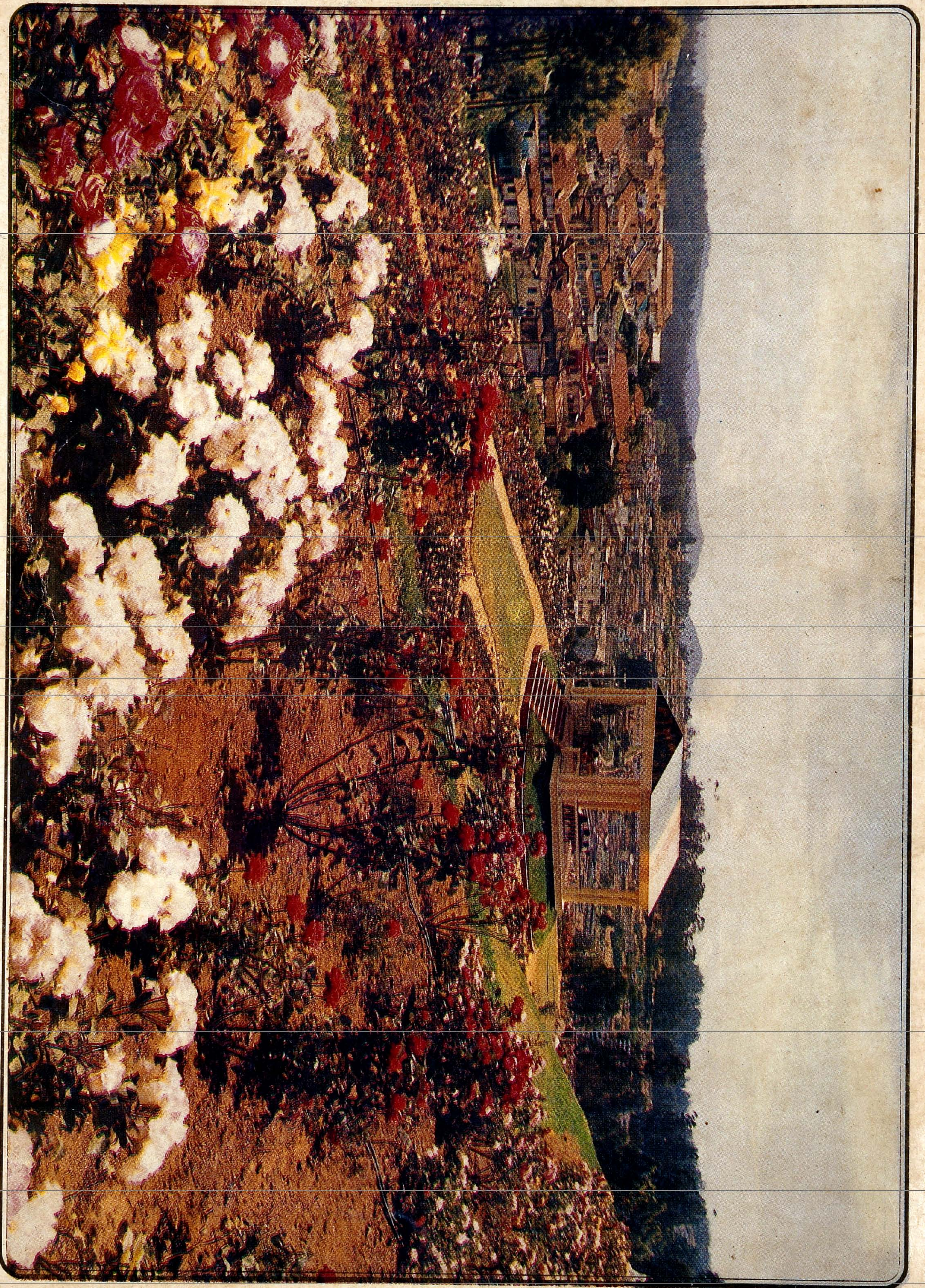
CENTENARY ROSE GARDEN,
UDHAGAMANDALAM.

The Rose Garden is situated in the lower slopes of the Elk Hill in Vijayanagaram Farm on the northwestern side, facing the Udhagamandalam Town. It is just about a kilometer from Udhagamandalam Railway Station and Bus stand and has easy access with motorable roads from two sides.

The rose varieties planted in this Garden were assembled from different sources. 17526 rose plants from 1921 varieties have been planted. The collection includes Hybrid Teas, Floribundas, Polyanthas, Miniatures and Creepers.

The garden consists of five broad terrace besides a service road.

- The first terrace is situated just below the approach from Bombay Castle Gate.
- The second terrace is the main part of the Garden. The latest varieties were planted here by grouping those based on colour shades like Vermillan, White, Yellow, Blend, Mixed Blue, Bicolour, Red, Pink etc. Roses were planted on either side of the terrace leaving centre part for the lawn, which is the living area of the garden. The lawns are laid out with Kikiyu grass and blue grass. The Nila Mandapam is located in a spot from where viewers can see the entire rose garden, beside the Udhagamandalam town. Garden structures like arches, bowers, benches – Octagonal and semi-octagonal summer houses, rose umbrellas, rose tunnel are placed in this terrace in vantage points in such a way that they blend well with the landscape. When all the rose varieties are in bloom, tourists can spend hours in this terrace admiring the diversity and beauty of rose cultivars colours, shapes and sizes of flowers.
- The third terrace is a small and elegantly designed terrace accommodating about 170 rose plants of floribunda varieties. The visitors can enter this terrace through the service road at northern end and also from the second terrace.
- The fourth terrace is a wide terrace almost rectangular in shape. This terrace is also planted with beautiful varieties of roses on either side leaving a footpath in the middle and on the northern end of the terrace a lawn has been laid out with Kikiyu grass.
- From the fourth terrace the visitors can enter the fifth terrace by connecting road or by footsteps. The slope between these two terraces is the largest, steepest and look like a majestic green wall. The footpath on the steps, structures, plants and sitouts give real thrill and adventure to the visitors. After visiting this terrace, one can have the satisfaction of having seen almost all the varieties of roses available in India in one place.